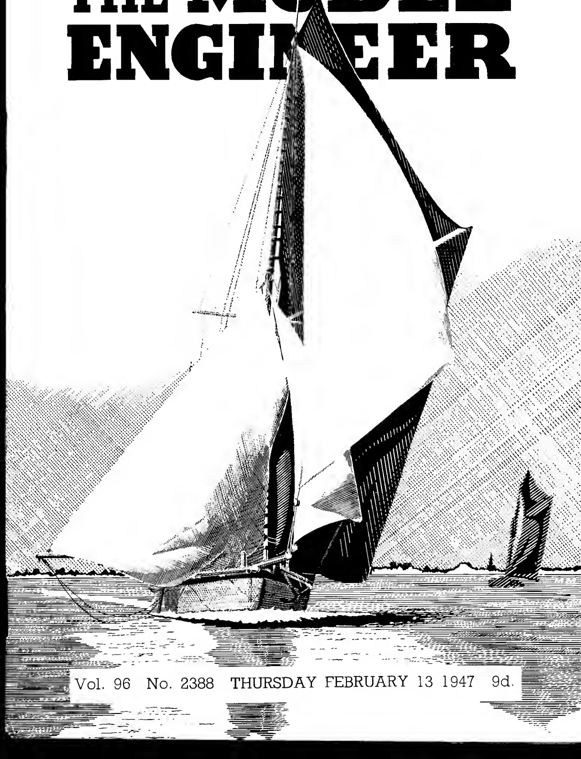
THE MODEL ENGINEER



Vol. 96 No. 2388 THURSDAY FEBRUARY 13 1947 9d.

THE
MODEL ENGINEER
Percival Marshall & Co. Ltd., 23, Great Queen Street, London, W.C.2

SMOKE RINGS

Thames Barges

THE sailing barge has for a century past been a feature of the River Thames, a picturesque, efficient, and superbly handled carrier admirably adapted to the trading needs of London's river and the navigation of the creeks and channels of its widespread estuary. Artists and model makers alike have been attracted by its sturdy and colourful appearance and have sought to perpetuate its reputation and its memory by their skilful work. It is, alas, being dethroned from its pride of place on the river by the small motor coaster, and though it may still be seen occasionally under sail, it is more in evidence in laid-up idleness out of the main traffic stream. Normally these vessels appear to be making their voyages in an extremely leisurely fashion, but their skippers are noted for their skill in taking advantage of every slant of the wind and set of the tide. They can even show a fine turn of speed at times, and the annual sailing barge race is an event which brings out the best in both boats and men. On our cover this week our artist shows a Thames barge under full racing sail in which she has a surprisingly yacht-like appearance. This effective picture was inspired by a photograph which will be one of a series in a very attractive book on these famous craft by our contributor, Mr. E. J. March, now in preparation for publication from our office a little later in the year.

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Model Car Racing

THE development of model car racing in this country provides material for speculative thought. Will it follow the pattern set by model power-boat clubs and become primarily a test of skill in design and construction for its followers, or will it emerge from its present experimental stage as a sport in which commercial interests will play as prominent a part as they apparently do in the United States? Will it, in fact, become a form of exciting diversion and achievement in which the rivalry of commercial engines and car equipment will be the dominating feature, rather than the pride of the individual builder who races his own self-made car for his own satisfaction? Much will depend on the financial rewards which may become possible. If substantial money prizes are to be won by successful racing, and if public admission to race meetings results in the promoting body making appreciable profits, then I think the hobby will have to be viewed from a new standpoint. It will bring into being a new enthusiast, the racing car owner as distinct from the car builder, and the laurels of the sport may go to the one with the deepest pocket rather than the cleverest pair of hands. It may also attract promoters of race meetings who are more concerned with the proceeds from the gate-money than with the technical merits of the cars. Model car racing will always have its rightful sporting side among owner-builders, who are naturally interested to see what their cars will do against the clock and are content with the modest honours which club contests can offer them. But if financial considerations become the dominating issue, then the hobby will assume a much wider outlook and will present many new problems. It will be interesting to see if the sport-loving public will take to the excitements of model car tracks after

the novelty has worn off, unless the element of gambling is introduced as an added attraction, which Heaven forbid. Shall we ever hear of the doping of the favourites at a model car meeting?

Talking Models

A LITTLE while back I suggested that in public museums a "talkie" attachment might be provided for models and other exhibits whereby a verbal explanation of the features of the model could be given, at regular intervals, for the benefit of a group of visitors. I was very pleased to find this idea in actual practice on the stand of Messrs. William Denny and Brothers Ltd., the well-known Dumbarton shipbuilders, at the Shipwrights' Exhibition. It was applied to a working model of the Denny-Brown ship stabiliser, in which a movable fin is caused to project from one side or other of the hull to neutralise the tendency of the ship to roll in that direction. The gramophone talking device was concealed in the base of the glass case containing the model, and in a short, but pleasingly-delivered speech, it explained exactly what was happening when the model was set in motion. Excellent as this device is, it would have to be applied with discretion in a museum or exhibition containing a large number of models. A babel of speeches in all directions would be embarrassing rather than instructive, but a considered timetable or rota for the talking models would solve this difficulty.

The Shipwrights' Exhibition

THE Worshipful Company of Shipwrights is to be cordially congratulated on the splendid collection of 2,000 ship models gathered in the two Halls of the Royal Horticultural Society in the Exhibition which has just concluded. The Company has held two previous exhibitions, one in 1877 and the other in 1882, both in the fine Hall of the Fishmongers' Company, in London. This year's display was, therefore, long overdue, for much progress has been made in the world of marine architecture since those days. The Lord Mayor of London, Sir Bracewell Smith, who opened the Exhibition mentioned that the Shipwrights' Company has under consideration the establishment of a permanent museum of ship models, though no site for this has yet been fixed. He also made another interesting point to the effect that the word "shipwright" covers the building of airships as well as ocean ships, and consequently the building of aircraft of all all kinds comes well within the province of this Company, which is now 700 years old. Most of the models on view at Westminster were admirable examples of craftsmanship, though I still noticed with regret the tendency of the professional ship modeller in some quarters, to overload his deck-fittings with gold or silver plate. Indeed, in one instance, so lavish was the plating that the model might have been described as "worth its weight in gold." Mr. Walter Pollock, the Chairman of the Exhibition Committee and his colleagues may well be proud of this instructive and fascinating exhibition, and in particular of the inspiration it afforded to the many shipyard apprentices who attended the show, and whose excellent work was particularly noticeable in the Prize Competition for the best models of the Ark of Noah. A happy thought, this competition, for apart from the constructive ingenuity it evoked, it symbolises the motto of the Company —"Within the Ark, Safe for Ever." We shall publish a report of the more interesting models in our next few issues.

Ship Models at Sunderland

SHIPBUILDING was a Sunderland industry 600 years ago, for a record exists of a shipyard at Hendon, founded in 1346 by one Thomas Menvill, for which he paid an annual rental of 2s. Since those days the River Wear has seen the launching of many famous ships, not only in the long years of sail, but up to the most modern days of steam and motor ships of large tonnage. The 600th anniversary of this important industry was recently commemorated by an exhibition in the Museum and Art Gallery, sponsored by the Borough of Sunderland. There were over 200 models and exhibits of nautical interest associated with the River Wear, and a particularly pleasing section was devoted to working models made and lent by members of the Sunderland Model Boating and Engineering Club. These were boats which run regularly at club meetings at Roker Park Lake, and were not exhibited as being examples of "exhibition finish." In spite of this disclaimer, Admiral Lord Fraser, who was especially interested in the Club display, said he had seen many worse models in show cases. Mr. J. L. Holbrook, the Honorary Secretary, who kindly sent me a programme of the Exhibition, tells me that the Club is making good progress, both in the marine and locomotive sections, and promises me more detailed news in the near future. Meanwhile, to emphasize the importance of Sunderland as a shipbuilding centre, he tells me that in 1938 the local yards launched 169,001 gross tons, compared with the output of the whole of the yards in the U.S.A. during the same period, a little over 200,000 gross tons. This is a fine record. No wonder local ship modellers have the right atmosphere around them, and that the Sunderland model club flies a proud flag.

Calling Llangollen

MR. E. E. GILBERT would like to hear from readers in or near Llangollen who would be interested in forming a society in the district. Address: 35, Regent Street, Llangollen. (Tel. 2348.)

Address Wanted

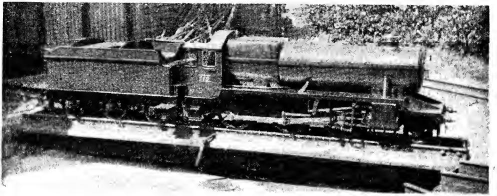
WOULD Mr. Donald Chamberlain who, when he sent us a letter under the heading "Traction Engines," published in our issue of July 13th, 1944, was a Corporal at H.Q. Air Command, S.E.A., kindly let us have his present address?

Percival Marshall

★"The Maid of Kent."

A New G.W. type 2-6-0 for the $7\frac{1}{4}$-in. gauge Saltwood Miniature Railway.
(Nr. Hythe, Kent)

by A. C. Schwab



THE water-gauge is a Stuart-Turner 3-cock pattern with $\frac{1}{4}$-in. glass, the fittings being screwed into a flanged column, studded to the back-head. An L.M.S.-pattern guard is fitted, consisting of a brass frame with three rectangular windows, but the back is left open and by rotating the frame on the gland nuts the open back can be brought round to the front. This is often advantageous if the light is bad or the mica has got dull and obscure, as it tends to do after a time, probably due to heat. Two screw-down type test-cocks are also attached to the column, as a standby. Incidentally, these, and other similar fittings, can be maintained in perfect working order even if they are not *used* at all for weeks on end, if a drop or two of cylinder-oil is dropped on to the spindles whilst under steam. The oil is thinned by the heat and drawn in by capillary action. No trouble with sticking or blockage of any kind has been experienced since making this a regular practice. The tip came from the late C. H. Willmott, of Wembley, to whom I was also indebted for the advice to fit a grate of wrought iron bars fastened together to form a sort of grid in preference to separate cast-iron firebars of the conventional type.

Each section consists of four bars of 1-in. × $\frac{1}{4}$-in. flat iron, the air space of $\frac{3}{16}$-in. being maintained by washers, whilst long rivets of $\frac{1}{4}$ in. diameter pass right through and hold the bars together. There are four such sections, the horizontal ones at the back being shorter than the forward sloping ones.

The grate sections rest on bearers studded to the bottom of the foundation ring.

There is no ashpan, but an efficient ashguard protects the rear coupled axle from heat and ashes.

Removal of ashes, etc., after the day's work, is very readily accomplished by inserting a hooked bar through the fire-door and fishing out the sections one by one through the door. The ashes fall through into the pit, the bearers, etc., are then brushed down and the grate sections replaced by hand from below. This means that the grate is perfectly clean and all air spaces absolutely clear ready for the next trip.

After three seasons' strenuous work, the original grate shows practically no signs of wear and tear. A spare set was made at the time the engine was built, but it looks as if it will still be a long time before it is needed. Also, there is no warping or distortion, and the scheme, as a whole, is a big improvement on the conventional practice of separate cast-iron bars.

Boiler feed is by an axle-driven pump, $\frac{5}{8}$ in. bore × $\frac{3}{4}$ in. stroke, and a Stuart "Cert" injector, either alone being quite sufficient to maintain full water level under the heaviest loads. The main clack-box (i.e. for the pump) is provided with a screw-down stop valve, this having a "wire-wound" wheel which also serves as a rest for the hand operating the regulator.

The injector steam cock and main blower valve are Stuart quick-acting screw-down valves, but the fibre hand-wheels have been replaced by G.W. type cock handles, which, to my mind, are an advantage, as they show clearly the amount of opening.

With anthracite one needs just a breath of

★*Continued from page 206, "M.E.," February 6, 1947*

steam through the blower all the time, otherwise the fire goes out when standing, so, to avoid the necessity of careful re-setting of the blower valve for every period of standing a small pilot or by-pass blower valve is provided on the steam fountain, alongside the main blower valve, with an $\frac{1}{8}$-in. pipe feeding into the main blower pipe. This little pilot valve is left permanently a quarter turn open all the time the engine is in steam and only shut off when the engine is put away.

The fire-door is of the "kitchen-copper" type, but is provided with a spring-loaded latch, so that when swung to, it automatically drops into a notch on the hasp, thus keeping the door just ajar to provide a little top air for the fire; it can, however, be pushed right home if desired, and then drops into a second notch.

Reversing is by a hefty lever provided with four notches in each direction, giving cut-offs of 89 per cent., 60 per cent., 45 per cent. and 28 per cent.

Lever was preferred to screw reverse because of the constant service slacks which do not give sufficient high speed running to allow of much full regulator and short cut-off working.

Quiet and Effortless

It may be of interest to note that the running, when fully notched up (i.e. 28 per cent.), is extremely quiet and effortless and the engine appears to be making much less fuss when passing the station with a 15-passenger load at speed on a slight down grade than, say a G.W. "Grange" passing Maidenhead at perhaps 65 m.p.h. on a relief portion of an up express, where the conditions of load, speed and gradient would closely approximate. Actually, I believe the "Halls" are regularly operated at 28 per cent. cut-off and about half-regulator.

The smokebox wrapper is a piece of $8\frac{1}{2}$-in. diameter S.D. copper tube, provided by Goodhand, but the front and door, instead of being castings, are fabricated from $\frac{1}{16}$-in. sheet copper, the dishing of the door being a particularly good example of my father's ability as a coppersmith —apparently a matter of intuition, as he has never had any instruction in the art. The best example of his skill is, however, the chimney (of the type fitted to the "Granges"), which is built up in the correct manner from tube and sheet; both this and the safety-valve cover were made to profile templates cut from tin sheet, the templates being marked-off from official G.W. blue-prints provided by Greenly.

The coning of the boiler barrel cleading was accomplished by bending it round the asbestos lagging, which was built up to the requisite "hump" by moulding a pulp of asbestos mill-board and water (of the consistency of purity) to the required contour. This was hardened by raising steam in the boiler—it sets very hard under heat and is superior to asbestos cement, which is inclined to powder and flake off.

The front end is decorated with a dummy vacuum brake-pipe, also a dummy G.W. type headlamp on the smokebox door. No lamp-irons are provided on the footplating, as they are a nuisance on a large passenger-carrying locomotive; and, in any case, the single lamp on the smokebox is the correct code, as my trains are "all stations" and not "express."

Lubrication of the cylinders and steam-chests is by a screw-down grease gun in the cab, feeding into the main stream pipe *via* a long $\frac{1}{8}$-in. pipe. This was originally fitted in 1940 as a temporary expedient, until a mechanical lubricator like *Trojan's* could be made and fitted, but has proved so successful that it is still in use and the mechanical lubricator has yet to be made.

It holds sufficient oil for a normal day's work, but needs re-filling on very busy days, i.e., those with a mileage exceeding ten miles.

Wick-feed "syphons" are fitted to the slide-bars, piston-rod mops and valve-spindles, all of the rest of the motion, etc., being simply provided with oil holes.

The rear coupled axle-boxes run rather warm owing to heat radiated from the grate, so their oil-wells are filled with cylinder-oil by a small motor-cycle grease gun provided with a long spout.

Brake blocks are fitted on the coupled wheels only, but prove amply powerful. The brakes are applied *via* a small hand lever which partly rotates a cam mounted on the top of a pillar, similar to that provided for a hand-brake. One finger is sufficient for a normal stop, and if too much force is used one pulls up violently and with a considerable "judder"! I much prefer this device to a steam brake, as it is very sensitive and one can "feel" the action directly.

As is common practice on Moguls and 2-8-0s, "mudguard" splashers are fitted over the rims of the leading coupled wheels to protect the slide-bars and piston-rods from dirt flung off when braking, or on a curve. Although an uncommon refinement in model practice, it is well worth while, particularly on a line with so many curves.

Large-diameter buffers, as on the new 10XX engines on the G.W.R., are fitted at the front end, as well as on the tender, this being necessary to prevent buffer-locking on the curves.

The tender is a fairly close copy of a standard 4,000-gal. type, but the wheelbase has been shortened by $1\frac{1}{2}$ in. to give easier running on the curves, also the wheels are under scale diameter.

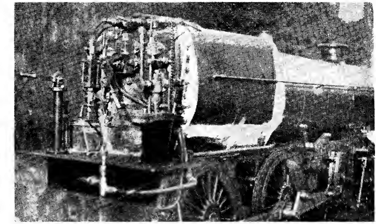
There are two separate water-tanks, built up of copper sheet and quite separate from the tender body. One, containing $3\frac{1}{4}$ gallons of cold water, feeds the injector, whilst the other, of 4-gal. capacity, feeds the pump with hot water, a live steam heater being provided, as on the old Stroudley engines. The high water capacity, $7\frac{1}{4}$ gallons in all, is made possible by the fact that the driver's feet rest on outside foot steps instead of reposing on top of the coal inside the tender body, as is usual practice in $1\frac{1}{2}$-in. scale. Coal capacity is high (16 lb.) for the same reason.

The driving position is much less cramped and one feels much safer on the curves with this type of foot-rest.

Performance on the Road

As previously stated, water level must be kept well up in the glass, owing to the small capacity of the boiler—similarly, on account of the relatively small grate area, only 50 sq. in. as against 61 on *Trojan*, the fire needs to be thick at the back and (i.e. under the door) though it can be tapered off to relatively thin under the tube-plate.

There is no brick arch. This is in accordance with normal G.W. practice, I understand.



Cab fittings, etc., of the new 2-6-0 G.W. engine. Photograph taken whilst the locomotive was under construction. Note the water-gauge guard

It is advisable to liven up the fire with the main blower (which *sounds* exactly like the vacuum ejector blowing off the brakes) for a few minutes before starting away after a stand—with *Trojan* it is best to start with a relatively "black" fire unless you want her to be "blowing the lid off," at the safety valves by halfway round the second lap!—if this is done, steaming is sufficiently good to enable one to gain water all the time if one wishes, or, alternatively, pass any excess steam to the feedwater *via* the heater to avoid waste of steam by blowing off.

Normal train loads in August are 14 to 18 passengers; *nominal* seating capacity of train is 11; but as many as 17 heavy adults, plus 6 children (23 in all) have been hauled quite easily, the total moving load in this case being estimated at nearly two tons.

Taking a load of 15 children as a typical case, the start from the station, which is on a very slight down-grade leading immediately off the platform end on to 1-in-100 up, is made in full gear with about half regulator or a little less, and notching-up begins after a few revolutions; by the time the summit is reached, i.e., halfway round the first lap, the gear would be in the next to the shortest notch and the regulator about one-third open. Once over the summit, the cut-off would be brought right back to the shortest notch (28 per cent.) and speed quickly mounts to some 8 m.p.h. down through the tunnel, on 1-in-200 down-grade, and is held at this on the succeeding straight level stretch towards the end of which lies the station. Usually, the lever is dropped forward by one notch for the recovery from the slack where the loop line through the carriage-shed rejoins the main line—the regulator opening is also increased to about half open for the second climb.

By "opening up" rather more vigorously from the start (but still by no means "flat-out")—i.e., say, two-thirds regulator and 60 per cent. cut-off shortened to 45 per cent. after crossing the pond it is possible to get the acceleration of an electric train, full cruising speed (8 to 9 m.p.h.) being reached within 100 yards of the standing start (all on adverse gradients). Even then, the beat remains surprisingly quiet, and this in spite of a $\frac{3}{8}$-in. diameter nozzle, as against *Trojan's* 13/32-in.

Trojan's beat sounds much sharper with the same load, and I can only assume that the 2-6-0's greater power (25 per cent. greater T.E.) added to greater mechanical efficiency (better designed valve gear and more generous wearing surfaces, etc.) enables her to tackle the same load under relatively easier steam.

Incidentally, a friend of mine, who remembers the Stroudley engines on the L.B.S.C.R. in their heyday, assures me that the "Maid's" beat is exactly like a Stroudley. Although soft, the beat is delightfully "chunky," even with only a breath of steam going through the cylinders, and anyone judging from the sound of the exhaust alone would, I am sure, say that she was a piston-valve engine. Actually, however, she has good-sized slide-valves, having a travel in full gear of 25/32 in.

As the valves are on top of the cylinders, a G.W. type snifting valve is fitted (on the right-hand side only)—this admits air to the main steam pipe before it enters the steam-drier coil, this latter consisting of about 5 ft. of $\frac{1}{2}$-in. copper pipe coiled round the chimney skirt in the upper part of the smokebox, so as not to interfere with the sweeping of the flues.

One surprising feature of the 2-6-0 is her freedom from slipping, even under the worst weather conditions. After three seasons, with every possible kind of weather (mostly foul!!) she has yet to give a real vigorous slip—all that she has done so far is to give a momentary slight slip (less than a revolution) just at the moment of starting.

This seems all the more odd in that sharp curvature is such a fruitful source of slipping, owing to the incipient slip caused by the inner and outer wheels trying to revolve at different speeds. The only possible explanation I can think of is the absence of long, hot dry spells in the last three summers—as running is only on Wednesdays and Saturdays some rain has generally fallen between successive public days, thus washing grease off the rails and applying a

thin film of rust. This seems to be borne out by the fact that *Trojan* herself (formerly a "holy terror" for slipping!) has been far less troubled in this respect during the last three seasons.

Although coal consumption (averaging 12 to 16 lb. per day of five hours) is almost exactly the same as with the "Atlantic," the water consumption is much less, and on one day last season only eight *gallons* were used, and this on a day when 280 passengers were carried and distance travelled was about 9½ miles. Average loads were 13 to 15 passengers. Normally, however, water consumption averages 10 to 15 gallons on busy days.

Last season's traffic was a record, the total number of passengers being no fewer than 3,768, and the total mileage 164, of which the 2-6-0 accounted for 108½ miles and *Trojan* the remainder.

Under War-Time Conditions

In conclusion, there are some notes on traffic working under war-time "front-line" conditions. As far as I know, the S.M.R. was the only passenger-carrying miniature railway operating regularly during the time of the flying bomb attacks on Southern England. Saltwood was, of course, right in "Flying-Bomb Alley," and many of the "doodles" were shot down in the vicinity.

Fortunately, none of the "routes" passed directly over the line, although Hitler operated regular services within quite a short distance on either side. A.A. guns were very thick on the ground, and so was the shrapnel!—or should it be "shell splinters"?

Many chunks of the latter landed close to the line and on one occasion I found two fairly sizable pieces, obviously only just fallen, quite close to where the engine was standing alongside the locomotive shed.

Naturally, traffic slumped heavily, as the local women kept their children at home for safety; there were, of course, no holiday-makers, but in spite of this we kept going until the end of August. Then, as the attacks seemed to be working up to a climax and hardly any passengers turned up, it was decided to close down; but, hardly had this decision been taken than the attacks ceased in this area, owing to the capture of the launching sites which affected our area. Actually, only one day—September 6th—was missed, and the running was resumed and continued well into the autumn. The year's traffic, in spite of the flying-bombs, compared very favourably with normal peace-time seasons—largely thanks to very busy Easter and Whitsun periods.

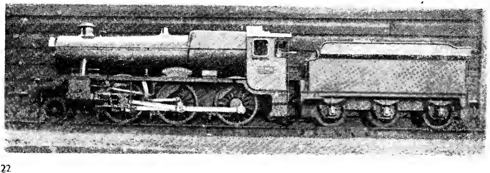
During the attacks, considerable use was made of the station as a shelter against shrapnel—fortunately, it has a good roof of heavy-gauge corrugated sheets. Due to trees, one could not always see the "doodle-bugs" as they approached, and the rumble of the train made it difficult for me to pick out their characteristic note. Consequently, I arranged with my colleague, who was in charge of the station, being a sort of booking-clerk-cum-foreman-cum-inspector and everything else, to signal to me if danger became imminent.

The cross-Channel gun duals did not affect us appreciably, as we were only on the fringe of the area they shelled, but we did get one or two stray shells towards the end of the bombardments.

Here is a table of leading dimensions of the new engine :—

Cylinders (2) dia.	2 in.
stroke	3 in.
Maximum valve travel	25/32 in.
Cut-off in full gear	89 per cent.
Wheels, coupled dia.	8½ in.
" pony truck	4¾ in.
Wheelbase, coupled	1 ft. 10⅛ in.
" total engine	2 ft. 11¾ in.
" total engine and tender	6 ft. 2¾ in.
Boiler :—	
Length of barrel	1 ft. 5¼ in.
Diameter "	8 in.
Working pressure	85 lb./sq. in.
Height of centre-line from rail	1 ft. 1½ in.
Heating surface :—	
Tubes (18 at ¾ in. dia.)	721 sq. in.
Firebox	320 sq. in.
Total evaporative H.S.	1,041 sq. in.
Steam drier	94 sq. in.
Total combined H.S.	1,135 sq. in.
Grate area	50 sq. in.
Total weight, engine and tender	About 5 cwt.
Tractive effort at 80 per cent. B.P.	96 lb.

Postscript: The boiler is roughly halfway (in size and power) between that fitted to the last variety of G.W. Mogul ("4321" Class as depicted in "British Locomotive Types") and the standard No.1 boiler fitted to the "Granges." The size of firebox exceeds that of the boiler fitted to the N and U Class S.R. Moguls, in spite of the relatively lower calorific value of the S.R. coal.



A GENERAL-PURPOSE DIVIDING HEAD

By G. H. Reed

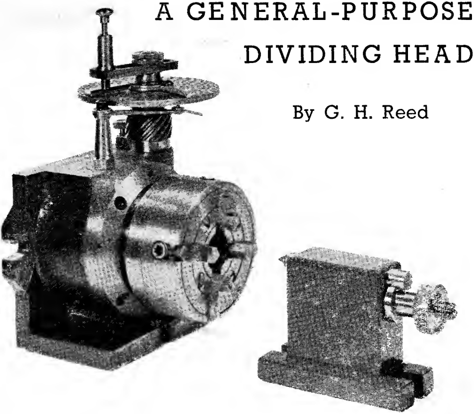


Photo by] [*Bernard Reed*

Dividing head and tailstock

THE design of this dividing head was chosen because it seemed to satisfy most of the requirements of a good dividing head, with few of the faults of the conventional type. Universal dividing heads the axis of which can be moved from the horizontal position to the vertical, and can be locked at any angle, are very useful, but it is usually found that when used in the vertical position on a milling machine, the face of the chuck is so far above the machine table that there is little room left to put a job in the chuck and a cutter on the spindle. The dividing head described here, when used in that position, has the face of the chuck only 5 in. above the table.

A further objection to the conventional type of dividing head is that the mandrel is usually bored for 3 or 4 Morse taper, and this limits the diameter of shaft that will pass through it. The machining of splines or equally-spaced keyways at the end of even short shafts becomes a very awkward operation, whereas if the shaft can be passed through the mandrel and held in the chuck, the operation is quite straightforward. In the case of the dividing head shown here, the mandrel is bored $1\frac{3}{8}$ in., more than sufficient for the class of work it would be expected to handle, but since it was an integral part of the design to use as short a mandrel as possible, to reduce the height when the circular table or chuck is in the horizontal position, it was deemed advisable to make up for the shortage by increasing the diameter. Thus, the outside diameter of the mandrel, where the races and the worm wheel are housed, is $2\frac{1}{8}$ in.

The head is equipped with a 6-in. circular table, a four-jaw chuck and a centre adaptor for use with the tailstock, the centre height of which is 3 in. There are two holding-down bolt lugs for each position, and dowel strips, for location in the milling-machine table slots, in each position.

An independent chuck is used in place of the more usual three-jaw S.C. type, because such chucks so seldom justify their nomenclature, and since the worm can be thrown out of engagement, it is possible to swing the chuck round easily for setting up purposes.

As to the construction of the head, the body and cover-plate are cast iron, and the 45-deg. thrust bearing in the cover-plate is bushed with phosphor-bronze. The mandrel is turned from a piece of scrap Bofors' barrel, though it is of such dimensions that mild steel would have

sufficed. The advantage of the use of races, rather than plain bearings, is questionable, but they happened to be available, and though they are light-duty, they are ample for the job. The worm-wheel is of phosphor-bronze, and was hobbed in the usual way, by first gashing the blank at the helix angle of the worm to a depth of about 0.030 in., and then meshing the hob with the blank, so that as the hob rotates and cuts, it also turns the blank round. This operation was carried out in the lathe, with the hob between centres, and the blank carried on a free-running bearing on the top slide. The hob was made of good carbon steel, and although its diameter is only $\frac{7}{8}$ in., it has eight flutes, as experience has shown when using the hob to turn the blank, it is of necessity the cutting edges that take the load of the turning, and the more there are in contact at a time the better. It is found advisable to assist the rotation of the blank by hand, as, in the initial stages of cutting, it is possible for successive teeth of the hob to fail to span the gashes, should the blank "lose way" a little. When once the hob has got its teeth into the blank, this trouble disappears, but the blank still requires to be assisted round, to avoid being cut only on the pressure side of the teeth. This can happen, and it will leave the mark of the gashing cut in the middle of a partly-machined tooth face.

The ratio between the worm and the worm-wheel is 80 to 1, as opposed to the customary 40 to 1. The reason for this is largely that the hob had been made for another job, and was of such a pitch that a 40-tooth worm-wheel would have been too small in diameter for the mandrel. The ratio is normally of little importance, as long as it is taken into consideration when calculating how many turns and parts of a turn are required to give the required indexing. The two index plates carry the standard number of holes. They were centre-drilled on a drilling machine, using a standard dividing head, and then drilled right through 3/32 in. Beneath the index plate there is a skew gear, which is part of the mechanism to convert the head for differential indexing, and if occasion offers, to use the head on a suitable milling machine for spiral milling.

The worm is $\frac{7}{8}$ in. diameter, with a pitch of $\frac{1}{8}$ in. and is mounted eccentrically in a bronze sleeve, which can be rotated to put the worm in or out of gear with the wheel.

The indexing handle is the conventional type, and the knob can be pulled out and twisted a quarter of a turn to keep the plunger from fouling the fingers when turning it.

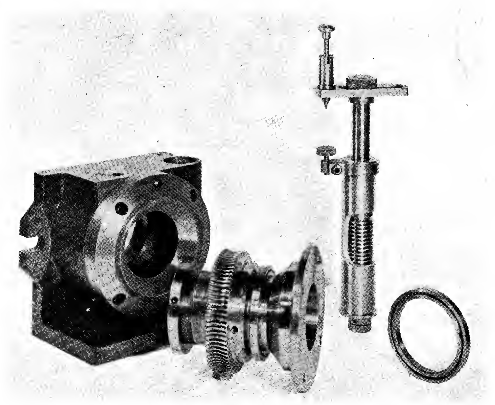


Photo by *[Bernard Reed*

Layout of parts of dividing head

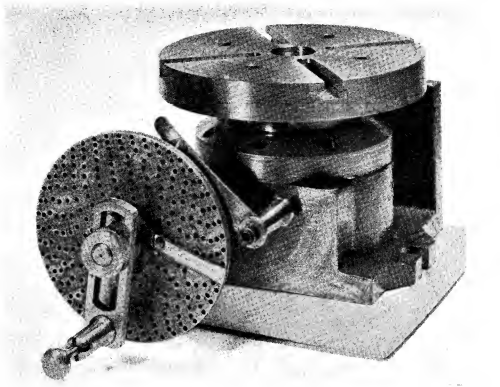


Photo by] [*Bernard Reed*

Dividing head fitted with circular table and used in the horizontal position

All the machining of the body was carried out on a 4½-in. lathe, including the hole for the worm sleeve. This was first drilled through ½ in. diameter—the maximum capacity of the drilling machine—and then set up on the vertical slide and bored out to diameter with boring bars running between centres.

The fitting of a suitable clamping device on the mandrel, to lock it while any cutting load is being taken, is at present under consideration. It is a necessary feature, as, although the worm does hold it, really heavy cutting would impose considerable strain on the teeth of the bronze wheel.

The Medway Model and Experimental Society

JANUARY 7th saw the Society's second annual general meeting, with some thirty-five members present.

Since the September Exhibition, membership had increased; the old workshop had to be abandoned and the chairman, Mr. R. Moody announced that a new and larger workshop had been obtained and hoped that we could take over in two or three weeks.

A workshop committee was formed under the direction of Mr. Kinke to install the workshop as soon as possible.

A report by the Society's committee was given *re* the future of a boating pool and railway track in the centre of Chatham ; negotiations had taken place with the Council that evening.

The track committee was elected for the construction of a 500-ft. track for 3½-in. and 5-in. gauges and cars.

It was proposed that a 3½-in. " Juliet " be built in the workshop by the junior members and supervised by the older hands.

Mr. Marriott proposed that parties be arranged to visit other societies' meetings and they be invited to visit our own.

It was agreed that the Society's next Exhibition should take place in September for a week.

The Society will exhibit at Maidstone and Ipswich Exhibitions.

Many thanks are due to Messrs. Wingets Ltd., of Rochester, for the loaning of the works' canteen for our club meetings during the past three months, and for the great interest the firm are taking in the Society.

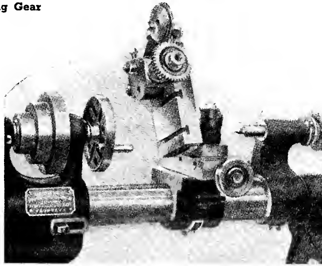
A great year lies ahead and new members are invited to write the Hon. Secretary : F. E. HOWLETT, 59, Bryant Road, Strood, Rochester, Kent.

*MILLING IN THE LATHE

By "NED"

Section 6.—Indexing Gear

A general review of the principles, appliances and methods employed for adapting the lathe for various types of milling operations



Simple indexing device and vertical slide, as formerly supplied for use on the 4-in. Drummond round-bed lathe

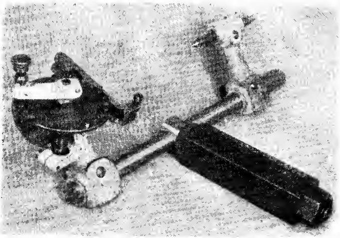
WHEN an accurate division plate or gear wheel is available to serve as a "master," it may be copied by means of a drilling spindle in the lathe. Play in the bearings of the spindle must be eliminated, or at least reduced to an imperceptible minimum, and a short, stiff drill employed, a small centre-drill being recommended, if the depth of hole is not too great. On no account should a division plate be copied by clamping it against the blank plate and drilling through the holes.

The "back-to-back" method of copying a division plate is recommended, however, in conjunction with a drilling spindle in the lathe. In this case, the master plate and the blank are mounted together, though not necessarily in contact, on a true-running mandrel between the lathe centres. A locking pin is mounted in a convenient position on the lathe bed to engage the holes in the master plate, the drilling spindle being mounted on the slide-rest, and used on the blank as each hole in the master plate is located and engaged. This method has the advantage of providing a sensitive "feel," by eliminating the friction of the lathe mandrel bearings, or other additional fittings which may be involved in fitting up more complex indexing gear.

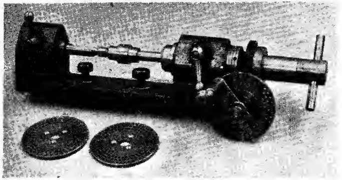
In the class of dividing attachments intended for use on the lathe slide-rest, the principles employed are similar to those of lathe headstock dividing appliances, but in addition, they embody extra features to facilitate mounting and (in some cases) vertical adjustment, also means for mounting work between centres or in a collet chuck. The function of a rotary-spindle milling attachment is often combined with that of a dividing attachment, by the provision of division-plates, either to mount direct on the spindle, or for use in conjunction with worm reduction gearing.

Attachments designed only for dividing do not require

*Continued from page 174, "M.E.," January 30, 1947.



The Westbury dividing attachment



The "Quickset" dividing attachment

equipment far more primitive than that illustrated here.

The facility for using the lathe chucks on the spindle of the dividing attachment is extremely useful, as apart from saving the expense or complication of extra chucks, it enables a chuck to be transferred from the lathe mandrel nose with work *in situ*, and concentric accuracy thereby to be ensured in the milling operation. In most small lathes, however, the room available on the slide-rest is rather inadequate to accommodate large chucks, and their overhang is also rather excessive for a light dividing spindle. The use of chucks or other work-holding fixtures specially designed to suit the spindle is therefore highly desirable.

Some designers of these appliances, in their desire to promote rigidity, and the ability to handle large or heavy work, have succeeded in achieving only clumsiness and restricted movement, and it is often found that a light appliance, with limited capacity, is much handier to use, and of more practical utility.

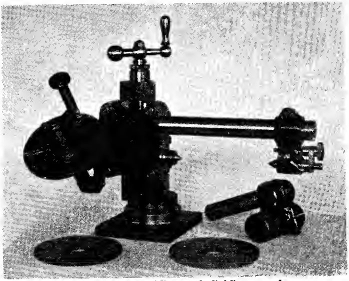
elaborate spindle bearings, but rigidity and elimination of both side and end play are essential. It is also desirable to provide some means of locking the spindle against rotation when necessary. It is, however, important that the locking device must not displace or produce any torque effect on the spindle when brought into operation. Some devices of this kind have been open to criticism, but the familiar split clamp method of locking is fairly sound if properly designed and carried out.

Many lathe manufacturers have supplied dividing attachments as special equipment for their lathes, and similar attachments, or parts for their construction, have been listed by many makers of accessories. One of the simplest of these attachments was that formerly supplied for use on the 4-in. Drummond ound-bed lathe. It consisted of a casting designed to mount on a vertical slide, and bored to carry a dividing spindle one end of which was screwcut to take the lathe chucks, while the other was provided with end-play adjusting collars, and turned down to fit the lathe change-wheels, the latter being thus utilised as division-plates. Indexing was effected by means of an eccentric wedge disc, similar to that illustrated in Fig. 51.

The vertical slide used in conjunction with this attachment was of special design to suit the particular lathe, but obviously, a simple device of this nature could be mounted on any type of vertical slide, on almost any lathe, and would be quite suitable for producing small spur or bevel gears to a sufficiently high degree of accuracy for most practical purposes. Work of this kind is often regarded as a *bête noire* by model engineers, but it is by no means as formidable as it looks, and excellent gears have been cut with the aid of

The "Westbury" Dividing Attachment

One of the handiest light dividing attachments ever produced was that described in THE MODEL ENGINEER over twenty years ago by Mr. E. T. Westbury. This device, illustrated in Fig. 54, embodied two headstocks mounted on a round bar, one of which carried the dividing spindle, with its indexing gear, while the other carried a double-ended sliding back centre. In its original form, indexing was effected by division-plates mounted directly on the spindle, in conjunction



The Poyser Universal milling and dividing attachment

either with a fixed detent, or a fixed division-plate and dowel pin, which enabled a multiplication of divisions to be obtained on the vernier principle. A worm dividing gear was, however, found to be much handier, the worm-wheel having 60 teeth and the worm shaft being mounted in a bracket adjustable around the headstock, so that it could be located in the most convenient position for operating.

The really novel feature of this appliance, however, was the method of mounting it in the lathe, which provided a universal latitude of angular adjustment, and made it possible to dispense with the use of a vertical slide for height adjustment. This was effected by mounting the slide bar in a cross hole drilled through the head of a tapered bolt, the latter being split on the centre line of the cross hole, so as to act as a split collet when drawn into a tapered hole in the shank. In this way, the slide bar was firmly gripped, and the rotational movement of the bolt simultaneously locked, by the tightening of a single nut. With the shank held in the lathe tool-post, the dividing centres could be brought into the required angle and position for operating on either spur, bevel, worm or skew gears as required.

Small diameter division-plates, with a single row of holes, were used with this device, to simplify operation and avoid taking up too much room. The plates could be produced in a few minutes by copying from the lathe change-wheels, with the aid of a drilling spindle. Despite the small size and lightness of the appliance, it could be used to cut involute spur gears in steel up to 2 in. diameter, using home-made cutters, or clock gears in brass up to 3 in. diameter, using fly-cutters. The blanks were mounted either on mandrels between male or female centres, or on tapered arbors to fit the socket of the live spindle, with or without the support of the back centre.

The "Quickset" Dividing Attachment

Another interesting light appliance of this nature is produced by the Quickset Tool Holder Co., of Stanmore, Middlesex, the dividing centres being in this case mounted in fixed headstocks in a single casting, which constitutes the frame or bed, and is intended to be mounted on a vertical slide. This is obviously a more rigid device than the previous one, but rather less versatile in scope, though it will deal with a wide range of gear cutting, tap or reamer fluting, and similar work.

The worm wheel in this case has 90 teeth, and three division-plates, each having three rows of holes, are supplied with the complete attachment. Locking clamps are provided on both the spindle headstock and the supporting centre, and the spindle nose is bored to take standard collets.

The "Eureka" Milling Attachment

Mr. J. B. S. Poyser, of Peck's Hill, Mansfield, Notts., has introduced many ingenious lathe attachments and other appliances in the past, and the "Eureka" Universal Milling Attachment illustrated here is one of his contributions to the

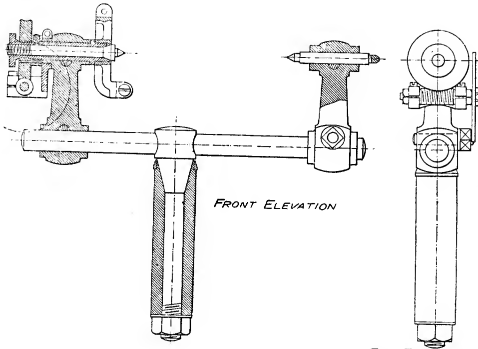


Fig. 54. Front and end elevations of the "Westbury" dividing attachment

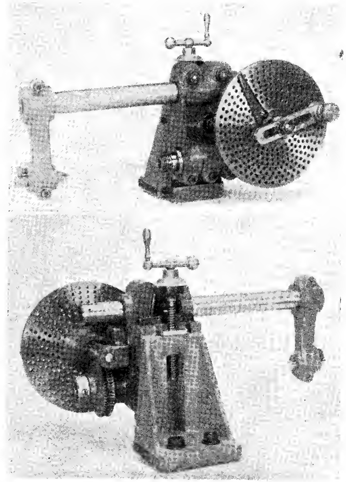
range of devices now under consideration. It can be used either as a dividing attachment or a rotary cutter spindle, and embodies its own vertical slide, with a rotatable base, graduated throughout the full 360 degrees. The headstock bracket is mounted on the vertical slide, and is bored with two parallel holes, of equal size, one of which carries a tubular "quill" or housing in which the complete spindle assembly is mounted, and the other the overarm or steady bar for supporting the back centre. The position of these two components is therefore interchangeable to suit the type of work being handled, and in addition, it is possible to fit the spindle at right-angles to the headstock, by making use of the combination bracket and bar seen to the right of the photograph.

The worm dividing gear can be completely detached from the quill, and a pulley attached to the spindle to enable it to be driven for use as a cutter spindle. A wide range of adaptability is thus afforded, and the appliance may be justly claimed to live up to the much-abused title of "Universal."

The "Myford" Dividing Attachment

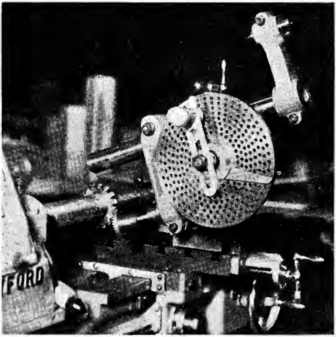
Within recent years, the Myford Engineering Co. have taken a very serious interest in the provision of attachments for increasing the versatility of their popular lathes, and in keeping with the general policy in the design of the latter, the attachments are simple, robust and comparatively low in price. The dividing attachment shown in the photograph is designed for mounting on the standard Myford vertical slide, either of the fixed or swivelling type. It comprises a headstock bracket, adapted to bolt against the face of the slide at any angle, which carries the dividing spindle and also the overarm, the latter being tubular to provide maximum strength in relation to weight. The worm gearing, with the division-plates supplied, gives an extremely wide range of divisions, and the rigidity of the assembly enables fairly heavy work to be carried out, providing that the lathe slides are in good order and correctly adjusted.

When cutting spur gears with an attachment of this type, it is usual to set the blank mandrel above and at right-angles to the lathe axis, lowering the vertical slide to adjust depth of cut, and traversing by means of the cross-slide from front to back, i.e. against the cutter rotation. With some of the smaller dividing appliances, it is possible to work with the blank below the cutter, which enables the progress of the work to be better observed; in this case the traverse should be from back to front, with normal direction of lathe rotation. Sometimes it is possible to arrange the arbor axis vertically, in which case the feed is applied by the cross-slide, and traverse by the vertical slide, upwards if at the front of the cutter, and downwards if at the rear.



Two views of the "Myford" dividing attachment

Skew gears—not true helical gears, but spur gears with teeth at a slight angle to promote quiet running—may be produced by swivelling the base of the vertical slide to the required angle, and working with the arbor horizontal. Worm gears may be "gashed" to about three-quarters of the tooth depth by arranging the attachment in the same way, but in this case the arbor is only fed vertically in the exact centre of the blank, and



Cutting a bevel gear with the " Myford " dividing attachment

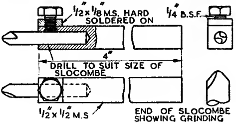
not traversed. Worm gears should always be finished by hobbing with a cutter of the same pitch and diameter as the mating worm, the relative angles of the work and hob spindles being the same as that of the worm and wheel; that is, usually at right-angles, though occasionally worm gearing is used for transmission at other angles. Worm gears cannot be generated, neither can true helical gears be cut, by simple attachments of this type, as some means of rotating the dividing spindle in relation to traversing movement is necessary for this class of work, but it is by no means impossible to devise attachments which will perform this work. In universal milling machines, the dividing head is geared to the traversing spindle of the machine table by means of change gears, to produce spiral motion; and the same principle has been successfully applied to milling in the lathe.

For cutting bevel gears, the work arbor can be set at an angle in front of the cutter, and the feed applied by the cross-slide, with vertical traversing movement in an upward direction. In most cases, it is impossible to support the bevel gear blank between centres, as the extended mandrel would foul the cutter; it is, therefore necessary to use a socketed arbor or a collet chuck. Bevel gears having truly radial teeth can only be generated by a shaping process, but a sufficiently accurate approximation for most purposes may be produced by milling, if a cutter narrower than the finished tooth space is used, and side cuts subsequently taken to produce equal taper of teeth and tooth spaces. It will be apparent that a single " forming " cut taken with a gear cutter will produce a parallel tooth space, and an excessively tapered tooth. Two gears cut in this way would make contact only on the outside radial edges of the teeth, and could not possibly mate together sweetly.

Gears should always be cut in accordance with the formulae provided in reference tables of standard gearing, using cutters of the correct form, and feeding to the correct depth. Blank diameters are also highly important; the use of a micrometer is advised in machining gear blanks, and an index graduated in thousandths of an inch, on the feed screw of the attachment, will be found extremely useful in assessing the depth of cut. But gearcutting is not nearly so formidable an operation as it is often believed to be, and there are few amateurs who have tackled it in a determined manner who have failed to produce satisfactory results.

(To be continued)

A Simple Tool



The drawing shows a tool and holder I made and use frequently. The tool is simply a broken Slocombe drill ground to a radius to get a smooth finish. It is very useful, and as it is high-speed tool-steel, it cuts almost anything. I hope it may interest other readers.—R. JAMES.

*COUPLINGS

By

Old Gaumless

THIS is the last act in my series of articles dealing with direct methods of coupling shafts together, and the collection of oddments contained herein will remind readers of their Society's "bits and pieces" evening. I have raked through my records to find all the most interesting types of couplings that have been developed to handle special conditions, and it is certain that most of them will be "news" in the model engineering sense.

As with all the previous illustrations, I have chosen only those which I considered would best

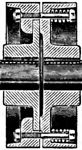


Fig. 2

convey a true picture of the types under consideration without the need for a great amount of written matter. They are all couplings in common use, and here they are.

Fig. 1. Oldham's Concentre Coupling

Invented by Oldham, for connecting the contiguous ends of shafts and ensuring the transmission of correct angular velocities should the axial lines vary, due to change of position of bearings or supports. All-metal construction, the centre disc *could* be made of non-metallic material if one wished to adopt it as a kind of flexible coupling. The "Perfect" flexible coupling described in a previous article is a development of the Oldham. A MODEL ENGINEER contributor re-invented it some time ago, much to my amusement, for the patent is 'donkey's years' old. A commercial coupling, 5 in. diameter, will transmit about 4 h.p. at 100 r.p.m. I have seen these couplings working, at slow speeds, with the axial lines of the shafts no less than 9 in. apart.

Fig. 2. Slipping Coupling

Designed to protect machinery, electric motors,

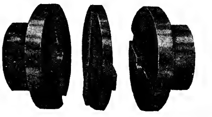


Fig. 1

etc., from breakdown, due to overloads, sudden shocks, etc., Can be set by means of the adjustable springs to slip at any pre-determined load and, once set, requires no further adjustment. Personally, I prefer this type of coupling to the "shear-pin" described below, because of better cushioning and no time is lost after removal of the obstruction in the driven machine. If the slipping surfaces are provided with textile friction linings, the slip should not be permitted to continue for lengthy periods for such practice results in rapid generation of heat, with consequent damage to the linings. The coupling can be designed to transmit almost any power.

Fig. 3. Shear Pin Coupling

Used for similar purposes to the above, i.e., temporary jamming of plant, such as stokers, rolls, stone-breakers, etc., the shear pin can be seen in the illustration situated inside the two set-screws shown in section. After removal of the obstruction, new pins can be fitted in a matter of minutes unless the "shear" is so ragged as to warrant removal of the set-screws. The pins are usually made from mild steel, brass or gunmetal. Practically every type of

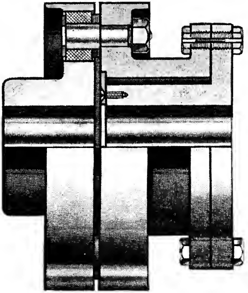


Fig. 3

*Concluded from page 649, "M.E.," Vol. 95, December 26, 1946.

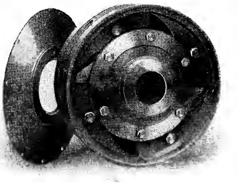


Fig. 4

coupling can be fitted with the shear pin device, the one illustrated being a pin type flexible, (*q.v.*, previous article).

Fig. 4. Differential Coupling

A pawl and ratchet arrangement for connecting

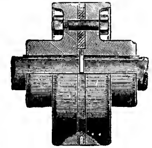


Fig. 5

or disconnecting the individual drives to shafts which receive the motion from two or more power units, the transmissive action of which is impulsive. The coupling connects the two shafts and breaks the connection automatically when the inner half lags behind in speed, or

removable centre disc, but the spigot (*q.v.*, article on "Rigid Couplings") should be dispensed with. The arrangement is useful in providing necessary clearance when the respective shafts have to be occasionally disconnected to run separately.

Fig. 6. Claw Coupling

Used as an expansion coupling or, when one half is arranged to slide upon the shaft, as a means of disconnecting two shafts. Fig. 7 shows the spiral jaw pattern for running in one direction only. This is sometimes referred to as the "ratchet" coupling, whilst the straight-jawed type is commonly called the "Dog." Fig. 8 illustrates a better arrangement of the "Dog" clutch, the internal jaws acting as a centraliser.

Fig. 9. Expansion Coupling

For expansion only, a much better job than the "Claw" for this purpose. The central member is gunmetal bushed to suit mild-steel pins, upon which it is free to move. When assembled, the shell becomes an oil bath, seals being provided to prevent leakage. Can be designed for any power.

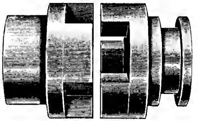


Fig. 6

Fig. 10. Long Boss Coupling

Whenever I have had to couple a new shaft to an old one and should it not be possible to remove the old shaft for the purpose of truing and straightening, keying and facing couplings, etc., I provide a much longer boss on the half

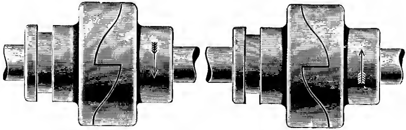


Fig. 7

when the outer half takes the lead. The inner half thus transmits power, but does not absorb it.

Fig. 5. Flanged Coupling With Removable Disc

Any rigid coupling can be so fitted with a

coupling which is to fit on the old shaft. The reason for this method is that the longer boss can get hold of more shaft, helping to reduce key-lift, overcoming shaft irregularities such as worn portions, bruises, etc., thus ensuring a coupling face as near true as possible under the circumstances.

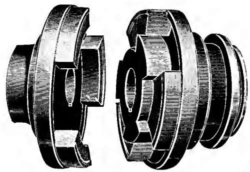


Fig. 8

Well, that is as far as I intend to go at the moment. I trust that my efforts to entertain you have succeeded in the direction intended, and that I have not proved too much of a bore. Allied to direct methods of coupling shafts together, are the indirect methods typified by friction clutches, etc., and, with the Editor's permission, I will, at some future date, prepare a comprehensive review of these interesting mechanisms starting say, fifty years ago, and ending with the last word in present-day development. It is certain that these latest designs will open the eyes of many experienced engineers, let alone we modellers. For instance, one now coming on to the market combines the duties of clutch, expansion coupling, universal coupling and, in addition, has proved to be the best flexible of the lot! However, all in good time. *Vale, Couplinius*! *Ave clutchus*!

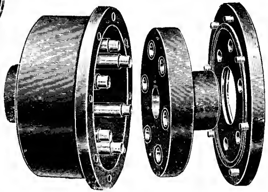


Fig. 9

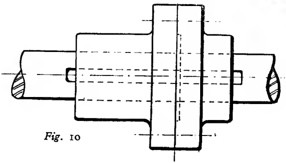


Fig. 10

(Illustrations by courtesy of Messrs. Crofts (Engineers) Ltd., Bradford.)

Sale Model and Engineering Club

The Club held their annual general meeting on Monday, January 6th, 1947, at the Clubroom, "Inglewood," Wardle Road, Sale, wherein officers were elected for the year. The Chair was taken by the President, Councillor F. Highley, who gave a resumé of the activities during 1946. The President welcomed His Worship the Mayor, Alderman R. P. Bannister, who, according to a new rule of the Club, was made an honorary member during his term of office as Mayor. In his address to the Club, the Mayor stated that the Corporation were taking deep interest in all social activities in the Borough and that he would give his support to negotiations between the Corporation and the Club regarding permanent premises for meetings and a workshop.

Mr. J. E. Griffiths, the previous secretary and founder of the Club, who is now living in Morecambe, attended the meeting and was elected a vice-president on account of his untiring efforts and outstanding work on behalf of the Club. The Mayor, on behalf of the members, presented Mr. Griffiths with a testimonial on parchment, an electric clock and an electric iron as a token of their appreciation.

The meeting was wound up in an excellent manner with a hot-pot supper.

A meeting was held on Monday, January 20th, when Mr. F. W. Waterton demonstrated his 20-c.c. two-stroke marine petrol engine and magneto, installed in his tug boat, "The Acklam Cross." In June last, Mr. Waterton was awarded the Mary Griffiths Silver Cup in respect of the engine and magneto. The engine is to Mr. Waterton's own design and incorporates the highly efficient "1831" carburettor; it has replaced the steam boiler and engine originally installed in the tug, which won a high award at one of THE MODEL ENGINEER Exhibitions prior to the war. On test, the tug hauled two men in a heavy rowing boat.

Next meeting, Monday, February 17th, at the clubroom, Inglewood, Wardle Road, Sale, at 7.45 p.m.

Hon. Secretary: J. H. S. WILLIAMS, 154, Park Road, Timperley. Telephone: Sale 5486.

NEW STANDARD LOCOMOT

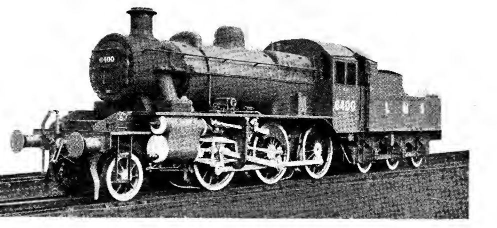
THE trend in locomotive development has been towards designing types able to deal with a wide range of traffic. At one time it was thought necessary to produce numerous designs to cover all the different variations of service and route, but interchange of locomotives after the railway grouping exploded the theory of special locomotives for special routes, and modern development in design and materials has greatly extended the scope of each individual type. The advantage of this development lies in the possibility of making use of the high in-built availability of been avoided by introducing successive modernised versions of these basic types, in which were incorporated the latest improvements in the art as they were available.

The position today is that eleven locomotive types can cover the whole of the traffic requirements on the L.M.S. from Wick to Bournemouth, and from Swansea to Lincoln.

Two of these types are new designs, namely, the Class 2, 2-6-0 tender and 2-6-2 tank engines, the description "Class 2" referring to L.M.S. power classification based on tractive effort and boiler capacity. The first examples of both

the modern locomotive by enabling it to take its turn on varying classes of traffic so as to attain a high annual mileage over which to spread its capital and maintenance costs. Another advantage is the economy obtained from standardisation and quantity production of renewable parts.

Since grouping, the L.M.S. has built new locomotives to a strictly limited number of basic types, but stagnation in development has types have just been completed at Crewe Works, to the designs of Mr. H. G. Ivatt, M.I.Mech.E., the chief mechanical engineer. They are of special interest in that it has not hitherto been the general practice on British railways to design and build new types for secondary services on cross country and branch lines. Old locomotives have usually been employed for this purpose, or even newly built locomotives to an old design.

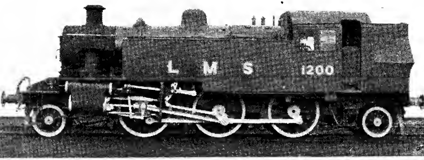


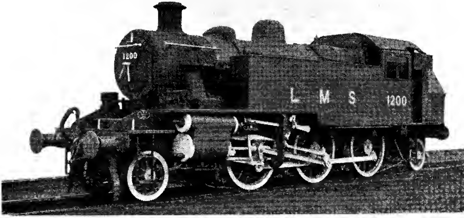
MOTIVES – L.M.S. RAILWAY

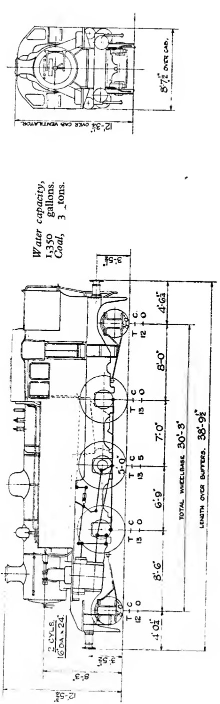
The new L.M.S. locomotives, however, although of small size and light weight, incorporate every modern development which has been found successful on the larger main line types. It is clearly desirable that secondary service locomotives, equally with main line, should be capable of the highest attainable mileage per annum and between repairs, that they should be quickly and easily serviced at the sheds, and that they should be economical to run. Since their prospective life may be over thirty years, they should also be capable of good acceleration and relatively high maximum speed so as to be able to meet any future speeding-up in branch line services.

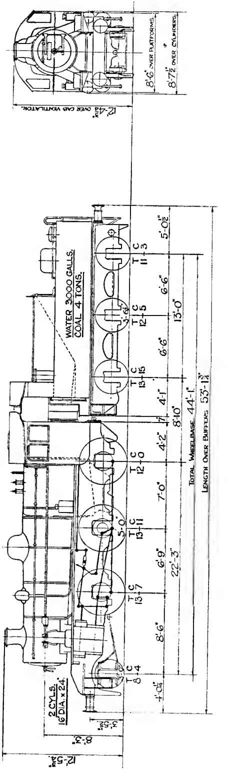
These requirements, the locomotives to the designs of twenty and more years ago, are unable to fulfil, and in producing the two new designs in question the L.M.S. was also influenced by the fact that a considerable number of Class 2 locomotives of old design would have fallen due for breaking up in the years 1939 to 1945 had the war not made it necessary to give them a further lease of life. Now, however, they are gradually being taken in for breaking up as their condition warrants and the new engines will take their place.

These two new classes are identical in design, except that one has a separate tender, and the other carries side tanks and coal bunker on its main frames. Both are intended for mixed traffic work, but the 2-6-0 engine is intended more for light main line and cross country freight and passenger working where greater coal and water capacity is required, whereas the 2-6-2 tank engine is intended more for branch line working including push-and-pull services. In both types attainment of very low axle weights has been essential in order that they could run practically all over the system, including minor and lightly laid branch lines. The description which follows applies primarily to the 2-6-0 engine with appropriate references to the 2-6-2 where necessary.






Water capacity, 1,350 gallons.
Coal, 3 tons.
12'-3¼" OVER CAB VENTILATOR.
8'-7½" OVER CAB.
2 CYLS. 16" DIA. x 24"
TOTAL WHEELBASE 30'-3"
LENGTH OVER BUFFERS 38'-9½"
4'-0¼"
8'-6"
6'-9"
7'-0"
8'-0"
4'-6½"
5'-0"
3'-5½"
8'-3"
12'-5¾"


12'-4¼" OVER CAB VENTILATOR.
8'-6" OVER PLATFORMS.
8'-7½" OVER CYLINDERS.
WATER 3000 GALLS. COAL 4 TONS.
2 CYLS. 16" DIA. x 24"
TOTAL WHEELBASE 44'-1"
LENGTH OVER BUFFERS 53'-1¼"
22'-3"
4'-0¼"
8'-6"
6'-9"
7'-0"
4'-2"
8'-10"
4'-1"
6'-6"
6'-6"
13'-0"
5'-0½"
5'-0"
3'-5½"
8'-3"
12'-5¾"

The boiler is of normal construction and the shell is of carbon steel throughout. The barrel, which consists of two rings, is tapered equally at top and bottom, the outside diameter at the front end being 4 ft. 3 in., and at the firebox end 4 ft. 8 in. The front ring is in $\frac{1}{2}$-in. thick plate and the back ring in 17/32 in.

The smokebox tube-plate is of the drumhead type, and there are twelve flue-tubes $5\frac{1}{8}$ in. diameter outside and 7 s.w.g. thick, and 162 small tubes $1\frac{5}{8}$ in. diameter outside and 12 s.w.g. thick. The length between tubeplates is 10 ft. $10\frac{1}{2}$ in. A large steam dome is provided and contains a grid-type regulator disposed vertically. Top-feed clack-boxes of the latest type in which the clack valves and seatings are integral with the coverplate casting, so that only one joint is necessary to each feed pipe. Instead of perforated trays, a simple arrangement of sloping plates is secured to the longitudinal stays underneath the top feed outlet to deflect the incoming water round the barrel side clear of the tube nest.

Firebox

This is of the Belpaire type, with a steel wrapper plate 17/32 in. thick. The inner firebox is of copper $\frac{9}{16}$ in. thick. Monel metal side stays $\frac{5}{8}$ in. diameter are mainly employed with $\frac{11}{16}$ in. diameter in certain rows where the tendency to fracture is greater. All stays are nutted on the fireside.

The firebox is 5 ft. 11 in. long outside and 4 ft. $0\frac{7}{16}$ in. wide, giving an area of the grate of 17.5 sq. ft.

A rocking grate is provided and this consists of six rocking sections divided into two groups of three fore and aft which may be rocked independently. The operating gear is so arranged that two different travels may be employed, i.e., the full travel for fire-dropping when the engine is over a pit, and a shorter travel for agitating the fire to eliminate ash and break up clinker whilst the engine is out on the road.

The ashpan is of the self-emptying type, having two bottom "flap" doors; these are connected by a linkage and operated by means of a lever from the ground. One front damper door only is provided.

Smokebox

This is of the plain cylindrical type with a solid bottom resting on a saddle of conventional design. The blast pipe has a plain circular cap of $4\frac{3}{8}$ in. diameter, which incorporates the blower ring.

The smokebox is of the "self-cleaning" type having plates and wire mesh grid arranged in such a way as to eject all accumulations of char through the chimney when the engine is working.

Main Frames

These are of the conventional plate type and consist of carbon steel plates of 1 in. thickness. Hornstays of the type which are bolted direct to extensions downwards of the frame plates themselves are fitted, and in order to maintain the frames at the correct distance apart pin-jointed cross stays are attached across the engine from driving hornblock to hornblock.

Horn Guides and Axleboxes

The driving horns have one-piece hornblocks of the "horseshoe" type, whilst the leaders and trailers have separate guides. All are fitted with composite liners bolted to the horn guides. These liners consist of flanged plates of manganese steel riveted and welded to mild-steel backing plates. The faces of the axlebox in contact with the horn guides are also provided with manganese steel liners welded to the body of the axlebox.

The coupled wheel axleboxes are steel castings with pressed-in horseshoe brasses. A sliding underkeep of gun-metal, which has an ample oil capacity and contains a worsted trimmed oiling pad is provided, and the oil feed from the mechanical lubricator is fed direct to the underkeep, thus permitting an uninterrupted bearing surface of the crown of the box. The journal diameter is $7\frac{1}{2}$ in. and the length of the bearing $8\frac{3}{4}$ in.

The two cylinders of 16 in. diameter and 24 in. stroke are disposed outside the frames, and 8 in. diameter valves of the piston type are operated by the conventional Walschaerts valve-gear. The links comprising the "lap and lead" motion of this valve-gear as well as the reversing gear, are fitted with case-hardened steel bushes and pins of the same material, and these are being lubricated with grease. The remaining links and details have phosphor bronze bushes, and are oil lubricated.

The piston head is designed to incorporate a bronze spring-loaded slipper which carries the head in the cylinder. For reasons of weight saving the crosshead is of a new built-up design.

Springs and Suspension

All three pairs of coupled wheels are provided with laminated springs with compression spring hangers and two types of spring are being applied for comparative purposes. Those of L.M.S. design have eight plates, 5 in. $\times$ $\frac{5}{8}$ in. section, working at a span of 3 ft. 6 in. centres when loaded. These are of carbon steel and the top plate has forged eye ends. The plates are secured in the buckle by means of a vertical rivet. The second type of spring is designed and manufactured by Messrs. William Griffith and consists of six plates 5 in. $\times$ $\frac{11}{16}$ in.. and, of course, the same working span of 3 ft. 6 in. The feature of these springs is that the top three plates have projections on each side at mid-span which fit into slots in the buckle and so prevent any movement of the plates in the buckle. In addition, an elongated cotter rivet is fitted to hold all the plates together. A further speciality of the "Griffith" spring is that the plates are ground and shot blasted in order to increase the fatigue resistance.

Pony Truck (and Trailing Truck of 2-6-2 Tank)

The same design of truck is used for the leading wheels of both the tender engine and the tank. It is of the bar-framed type and side control is effected by swing links. A spring-loaded friction retarder is provided to supply the necessary

(*Continued on page 242*)

"L.B.S.C's." Lobby Chat

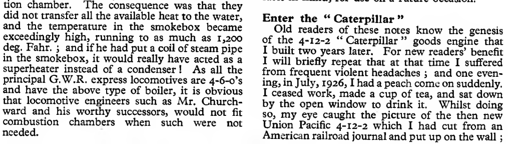
About Combustion Chambers

IN the issue of December 26th last, our worthy friend "Uncle Jim" makes the statement that there is still a large scope for experimental work—with which I heartily agree; we learn a lot that way—and cites as an instance, the use, or otherwise, of combustion chambers in locomotive boilers. In order to save any prospective experimenter wasting a lot of valuable copper in these days of eternal (? infernal) shortages, maybe if I chronicled the results of my own experiments in this direction, there would be no need to go over the same ground again; and anybody who wishes to proceed with the job, can start where your humble servant left off. First of all, I might mention that with the ordinary short-barrelled 4-4-0, 4-6-0 or similar boiler, with a narrow firebox between the frames, there is not, and never has been, any need for a combustion chamber. J. E. McConnell, who was locomotive superintendent of the Southern Division of the old London and North Western Railway, tried combustion chambers in this type of boiler some 95 years ago, and found that the length of the tubes was much too short, compared with the combined length of firebox and combustion chamber. The consequence was that they did not transfer all the available heat to the water, and the temperature in the smokebox became exceedingly high, running to as much as 1,200 deg. Fahr.; and if he had put a coil of steam pipe in the smokebox, it would really have acted as a superheater instead of a condenser! As all the principal G.W.R. express locomotives are 4-6-0's and have the above type of boiler, it is obvious that locomotive engineers such as Mr. Churchward and his worthy successors, would not fit combustion chambers when such were not needed.

Now, coming down to the little sisters, back in 1924, I built a four-cylinder 4-6-2. She was not a copy of any existing type of locomotive, but an imaginary "artist's impression" brought to life, inasmuch as she was built to represent the engine drawn by Mr. Secretan as a heading for the "Pertinent Paragraphs" section of the *Railway Magazine* at that date. The boiler was a long-barrelled wide-firebox contraption, about as big as it was possible to put on the frames, in accordance with the above-mentioned drawing, and contained twenty-two $\frac{3}{8}$-in. tubes and two superheater flues. I forget the exact tube length, but it was what I thought at the time was excessive. There was no combustion chamber. The boiler steamed the four cylinders all right, but it took rather a long time to get up steam from all cold; and at times, working in the open air, it was possible to put your hand on the smokebox without much discomfort, proving that the front part of the tubes was not doing much toward "keeping the pot boiling," even if they were doing anything at all. I did nothing about it at the time, as the engine did the job all right, but kept the facts in mind, for use on a future occasion.

Enter the "Caterpillar"

Old readers of these notes know the genesis of the 4-12-2 "Caterpillar" goods engine that I built two years later. For new readers' benefit I will briefly repeat that at that time I suffered from frequent violent headaches; and one evening, in July, 1926, I had a peach come on suddenly. I ceased work, made a cup of tea, and sat down by the open window to drink it. Whilst doing so, my eye caught the picture of the then new Union Pacific 4-12-2 which I had cut from an American railroad journal and put up on the wall;



Mr. Douglas Picknell put some fine work into his "Princess Marina"

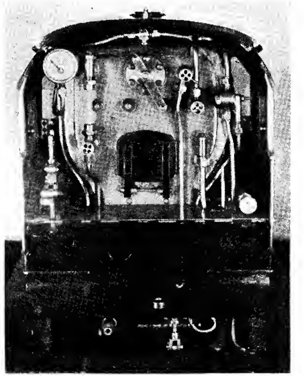
and I thought what a nobby time I would have with a similar type of engine built to British outline, bringing up a train of about 200 wagons from the South Wales coalfields to London. Then I thought what a crackerjack a similar engine would be in 2½-in. gauge, for passenger-hauling on club or exhibition tracks, and then came the startling thought—*why not build it?* That did it! I drank up my tea, forgot all about the headache, and at 11 p.m. that night the frames were cut out and erected; as you know, I need no drawings. The engine was completed and running 43 days later; but that is getting ahead of what I wanted to record.

The American engine had three cylinders; I fitted four to mine, with the 135-deg. eight-beat crank setting, and having a piece of 3⅞-in. by 16-gauge copper tube in stock, decided to use that for the boiler. Then it came into my mind about the Pacific and her cool smokebox, and thought I would try making the tubes a little shorter, extending the upper part of the firebox into the boiler barrel to meet them. My tentative arrangement, keeping to round figures instead of odd sixty-fourths, which I detest, was to have the length of tubes about equal to the combined length of firebox and combustion chamber. As the latter would, of course, need staying, by virtue of its flattened shape, I decided to use 16-gauge water tubes crossing the chamber, these acting not only as stays or struts, but increasing the heating surface in the most valuable part of the boiler, and helping the water to circulate vigorously. The firebox and combustion chamber were made from a single sheet of copper, the roof of the chamber being a continuation of the firebox crown sheet. The girder stays extended only over the firebox, as the water tubes rendered the combustion chamber self-supporting. I made everything as strong as possible, and used a large number of closely - spaced firebox stays, so that I could work her at "full-size" pressure if ever it were needed.

No trouble at all was experienced in building up the boiler, though I very nearly became a "hospital case" through the vaporiser of my five-pint blowlamp bursting whilst the brazing was in progress, sending a streak of white flame 4 ft. long, right across the shut-off valve on the feed pipe. How I escaped injury, and got the flame out, I don't exactly know; must have acted on instinct with the speed of greased lightning! Anyway, I had a spare vaporiser, a genuine Barthel, (the original was a "Government surplus" from the 1914-18 schemozzle) and so was able to complete the boiler, and erect it on the chassis.

A Fast Steamer

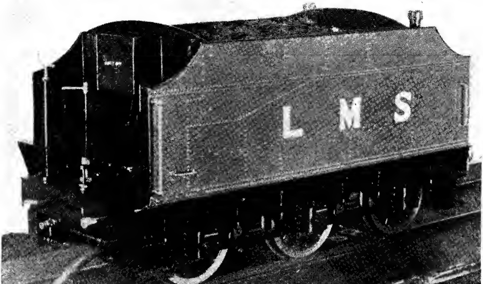
When first lit up, the boiler gave me a pleasant surprise by getting up steam in three minutes; a shade over half the time taken by the Pacific boiler, which was slightly larger in both barrel and firebox. The cylinder capacity of the goods engine was about the same as the passenger engine; but on account of the small wheels and the eight-beat setting, the blast was a continuous purr instead of sharp clearly-defined puffs. On her first run, the engine proved an amazingly free steamer; and I was able to enlarge the blast nozzle, so that with a normal load, the fire only burned dull red, yet she would blow off sky-high if the firehole door was shut. The improvement in general performance, over the boiler fitted to the Pacific engine, was so marked, that I decided in future to build every long - barrelled boiler with a combustion chamber; and that decision has been carried out. I wouldn't dream of building a boiler with excessively long tubes, after the experiences I have had, especially as the addition of a combustion chamber adds considerably to the firebox heating surface, which is the most valuable in the whole of the boiler.



Neatness de luxe

The Proof of the Pudding

About a year later, I built the original "Fayette," a 4-6-2 which was a combination of British and American practice. She was the first engine in this country, big or little, to have the Baker valve-gear; and



Mr. Picknell's straight-line riveting is exemplary

when the late Mr. R. E. L. Maunsell—at that time C.M.E. of the Southern Railway—visited my old home at Norbury to examine the gear and see it in action he said she was the most symmetrical Pacific he had ever seen. "Fayette's" boiler had a combustion chamber, but was constructed in a different manner to that on the "Caterpillar." Instead of making the firebox and combustion chamber all in one piece, the firebox was made separately in the usual manner, but with one big oval hole in place of all the usual tube holes. The combustion chamber was made from a piece of large-diameter seamless copper tube, flattened to the required shape; and the water-tube struts, instead of being placed across the chamber at an angle, were almost vertical. The actual dimensions of the boiler were much smaller than those of the "Caterpillar," the engine having two cylinders only, and large driving wheels. All the joints were brazed, except the tubes, which were fixed in their respective tube plates by best-grade silver-solder.

This boiler also raised steam in three minutes, and when the engine was at work, the safety-valves would blow off all the time the firehole door was closed, even with the pump feeding the boiler. I gave instructions in this series of notes on how to build a similar engine; and when we came to the boiler, there were the usual quibbles from Messrs. Theory, Orthodox and Co. Unlimited. Some averred that the combustion chamber was unnecessary ("paper calculations" again—of course they hadn't *tried* it!) and others thought that the same result could be obtained by using large-diameter tubes in lieu of the combustion chamber; there were other "moans and groans," but I need not detail them here. I knew the large tube idea was "goofy," because it was only one step down from "Bro. Iron-wire" Alexander's boilers of a quarter-century previously; and I had actually seen working, and examined a $2\frac{1}{2}$-in. gauge Pacific fitted with an ordinary long barrelled boiler and firebox, the barrel containing six $\frac{3}{4}$-in. tubes, four in the upper row and two below it. This engine was a professionally-made special job at a three-figure price. The engine took practically twice as long as did "Fayette" to get up steam; when she was running with a load, the heavy blast transferred quite a lot of the contents of the firebox into the smokebox, and that component became so hot that the paint on it was blistered. It is true the engine steamed; but it was at considerable effort, and there was a lot of fire-throwing.

The "Fayette" serial was popular, and many engines were built; but some of the builders were shy of making the boiler with the combustion chamber, partly on account of the extra work involved, partly because they listened to tales from "people who know" (and seldom, or never, build a locomotive themselves!) and partly from prejudice. One of the latter got into communication with me, and flatly insisted that his ordinary boiler with long tubes was perfectly satisfactory, and fully equal to one with a combustion chamber; and to settle the matter, I invited him to try his engine on my old road at Norbury, which invitation he accepted. The engine was a fine piece of work, the cylinders and motion being very well-made, and according to instructions. Using exactly the same steam-raising apparatus which I used on "Fayette," the engine took a few seconds under six minutes to get up steam, and would only maintain it when pulling a normal load, with the firehole

door shut all the time. "Fayette" herself promptly got up steam in three minutes, did exactly the same work with the firehole door partly open, used much less coal, and finished with only about a teaspoonful of ash in the smokebox, the other having quite a considerable amount, owing to the heavier blast necessary to maintain steam. The owner of the non-combustion-chambered engine said frankly that he was amazed, and "gave me best," in a manner of speaking; and I submit that there could be no more effective way of ascertaining which boiler was the more efficient, when the competing boilers were fitted to engines otherwise identical in every respect!

In the years before the war, when I had a little time available to do a few friendly jobs, I repaired several commercial and professionally-made locomotives having long-barrelled boilers and ordinary fireboxes; and in no case whatever, did I ever find these boilers perform anything nearly as satisfactorily as those with combustion-chambers, whether "O" gauge or $3\frac{1}{2}$-in. gauge. I'm not denying for one moment that they steamed, and steamed well; but there is a difference—in fact, a very marked difference! —between just steaming, and doing it efficiently. A case in point was the last job I did—and the last of that kind that I ever *will* do, if I know it—which I described in a recent issue; the case of the West Midland engine with the "wonky" cylinders and motion. That locomotive's boiler made plenty of steam, and could blow off all right, but it was a case of "shovel-and-pump," and plenty of blast all the time, to keep on the pin, although the cylinders were only $\frac{11}{16}$ in. bore and $1\frac{1}{16}$-in. stroke. I have here at the present minute, in my own "running-shed," an exactly similar engine, old "Tishy," rebuilt with one of my own boilers having a combustion chamber. The easy work she makes of hauling a three-passenger load, steaming without the slightest effort, and needing only half the coal consumed by the engine previously mentioned, is further concrete evidence as to which boiler is the more efficient.

Various Experiments

As regular followers of these notes are aware, I don't base any assertions on the result of one experiment alone, nor do I "rest on my laurels," being always anxious and eager to learn, though unfortunately, "lessons" are being much curtailed by anno Domini and other inescapable circumstances; but after the good results obtained from the "Caterpillar" and "Fayette," I carried out quite a lot of experimenting, to find out what effects were obtained by varying the lengths of firebox, combustion chamber, and tubes. There is no need to go into full detail of all the different variations tried out; suffice it to say that the most efficient boilers were those in which the length of the tubes equalled or very slightly exceeded the combined length of firebox and combustion chamber. Varying sizes and positions of water-tube struts were tried. In the original "Caterpillar" boiler, two were vertical, the rest inclined, and the whole doings arranged in a sort of staggered formation. I tried all vertical, and all inclined at various angles, in subsequent boilers, and found that the best results were obtained from the arrangement I now specify, as exemplified in "Hielan' Lassie," "Bantam Cock" and other engines with similar boilers.

One solitary experiment with an ordinary 4-6-0 boiler having a narrow firebox, proved that McConnell's results still held good with little engines; the smokebox became terribly hot, and the boiler showed a distinct tendency to prime. The combustion-chamber water tubes in this case, stirred up the circulation too vigorously; and the inside of the boiler, when the engine was pulling hard, must have been one mass of seething bubbles. It was impossible to get a true reading in the water gauge. I wondered, however, how a combustion chamber would do in a boiler with a wide firebox, but only a medium length of barrel, such as would be found on an Atlantic engine, or a small-wheeled 2-6-2; and to that end, fitted a short combustion chamber to an Atlantic engine which I repaired for an old friend. The proportions were kept the same as on the Pacifics, viz., length of tubes slightly longer than the combined lengths of firebox and combustion chamber. The latter was a little stumpy extension of the firebox containing two water-tubes only. On test, the only advantage that was apparent, was that the boiler was a little quicker in getting up steam; on the run, there was nothing in it. There was just one point, however, that might be worth recording, and that was, that as the fitting of the combustion chamber shortened the tube length a little, it was possible to fit a nest of $\frac{3}{8}$-in. tubes instead of $\frac{7}{16}$-in., thus enabling a greater number to be used, with a small increase in the effective heating surface. Note that word "effective," as it is very important. The whole of the bottom of an ordinary domestic kettle is only *effective* heating surface when the utensil is placed on a good big gas ring, or on top of a bright fire. It wouldn't be very effective if you put a candle under it! I know of many boilers—have come across them in my experience—designed by "experts," with a big heating surface "on paper"; but a boiler with half the nominal heating surface has knocked them into a cocked hat when it came to steaming ability, merely because the smaller boiler's heating surface was all *effective*, whilst the others' was not.

Temperature is what Matters!

It was just the question of making all the heating surface effective, that enabled your humble servant to blow sky-high the old theory, that to make a small locomotive a success, it had to be fitted with the biggest possible boiler that could be placed on the frames. I always knew *that* wasn't right, even in childhood; maybe you recollect my reminiscence about my rigging up a caricature of a Stroudley tank, and finding that the boiler steamed better than another engine I had built with a larger one. I wondered why; enlightenment suddenly came one evening between Clapham Road and East Brixton, when having a drive on a "Terrier" tank, and the fireman said don't put the pump on, because the boiler steamed much freer when there was only half-a-glass showing. The less

water, within reason, of course, the easier for the fire to keep it at the required temperature; and it is the temperature of the water which settles the steam production, not the size of the boiler, nor "square inches of grate area, or heating surface." If the grate area, firebox volume, and length and diameter of tubes are properly proportioned for a given size of boiler, that boiler will steam like the dickens, and nothing will keep it quiet. In passing, I might mention for beginners' benefit, that I found, for boilers from 2½ in. to 6 in. diameter of barrel, that the most effective tube diameter is ⅜ in. up to 11 in. long, $\frac{7}{16}$ in. between 11 in. and 15 in. long, and over that, ½ in. The rule is not hard and fast, however; variation can be made according to the size and type of boiler. Tubes of ⅜ in. diameter can be used over 11 in. long in a boiler with a big firebox and a combustion chamber; or take another instance: In the boiler I have specified for a 3½-in. gauge G.W.R. "1000" class 4-6-0 (Swindon's latest). I adopted ⅜-in. tubes for a length of 11 in., as the firebox is long, with narrow grate, and plenty of volume, the upper part being swelled out, and acting as a combustion chamber; but if I specified a boiler for a wide-firebox Atlantic engine, and the tube length came out at 11 in. I should use $\frac{7}{16}$ in. tubes, as the upper part of the firebox tapers inwards, and there is not so much room for the proper combustion of the gases.

Summing-up

In the above lobby chat I have placed my cards on the table, in a manner of speaking, and it is up to any experimenter to go ahead and trump all the tricks if he is in a position to do so; but don't try it on with a slide-rule! This is a very useful instrument (I have one), but for boilers I prefer copper and Sifbronze. Also, don't expect to get absolutely conclusive results, either for or against combustion chambers, or, in fact, anything relating to boiler efficiency, by virtue of building merely one, two, or even half-a-dozen boilers. I have built with my own hands, plus the necessary tools and materials, something like 200 boilers, ranging from a weeny-weeny "OO" gauge Atlantic boiler with firebars made from blanket pins (it was shown in steam at a S.M.E. meeting at the Caxton Hall) to a huge 7¼-in. gauge boiler for a L.N.W.R. 4-6-0. The majority of them have been for 2½-in. and 3½-in. gauge engines; and without the slightest intention of blowing off any hot air—plain statements of facts are not idle boasts—I have never made one that did not steam. The results of that experience have been freely placed at the disposal of the readers of these notes, and I sincerely hope and trust it has saved many builders of little locomotives from having to "grope in the dark," and produce boilers which have failed in the job.

My experience is, that combustion chambers are not needed on short-barrelled boilers, either with wide or narrow fireboxes; but they definitely *are* needed where long barrels are used. This is borne out in full-sized practice. Practically all the American 4-6-2 and larger engines have combustion chambers, and they are also used on long-barrelled British locomotives. There was a standing joke among our fraternity about the L.M.S. "Princess Royal"; when she came out new, she had no combustion chamber. I described in a contemporary journal, how to build one in 2½-in. gauge, and specified a combustion chamber. Some time after, the big engine went in for "heavy shopping," and when she came out again, lo and behold! she had a combustion chamber. The lads of the villages said that the C.M.E. must have been reading your humble servant's notes, and had profited thereby!

New Standard Locomotives—L.M.S. Railway

(*Continued from page 237*)

damping. The trailing truck of the tank engine is of a simi'ar design, but has spring side control.

The beaıing springs are of the coil type, and the axleboxes of bronze have a journal size of 6¼ in. diameter and 10⅞ in. length.

Tender, Cab Tanks and Bunker

The tender of the 2-6-0 engine is of a completely new design and is arranged to give good conditions for tender-first running. The tank, which is to all intents and purposes rectangular, affords a good visibility from the cab which is provided on both engine and tender. The coal bunker which is also of rectangular section is narrower than the tank.

The construction of the tender tank, as well as the tanks and bunker of the 2-6-2 engine is partially welded, partially riveted.

Equipment

The following is a list of the principal items of equipment provided:—

"Monitor" injectors.

Steam brake on engine and tender, with vacuum brake fittings for working fitted trains, and the standard combination driver's brake valve.

Water pick-up gear on the tender of the 2-6-0.

"Silvertown" mechanical lubricators to cylinders and axleboxes.

Steam sanding gear.

Grease lubrication of brake and water pick-up gear pins, and to the rocking grate and ash-pan gear.

Manually operated blowdown in addition to the standard continuous blowdown equipment.

Carriage warming apparatus.

Fire-iron tunnel placed on right-hand side platform in front of the cab on the 2-6-0 engine.

Engine Numbers

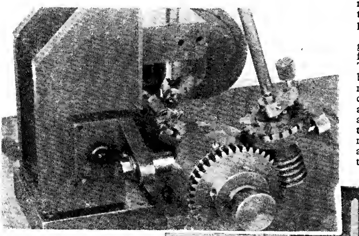
The ten 2-6-0's to be built this year are to be numbered 6400-6409 and the ten 2-6-2 tanks 1200-1209.

*A GEAR-CUTTING MACHINE

By J. S. ELEY

THE swinging arm is secured in its seating by a clamping lever, and can be locked in a 90-deg. position for spur-gear cutting by a knurled-headed pin. The cutter spindle is ground, and runs in a honed cast-iron bearing $2\frac{1}{4}$ in. long, no provision being made for taking up wear. If a well finished spindle is carefully let into a honed cast-iron bearing and adequately lubricated, it will stand an enormous amount of wear. I know of an engineering works where some special lathes with *cast-iron* spindles running in solid cast-iron bearings have been running for years without appreciable wear. It would appear from the illustrations that this spindle has rather a large overhang. However, the assembly has proved remarkably rigid, and has given no trouble on that score.

A plain drive was originally fitted, but it was soon found that when cutting steel gears sufficient power could not be got to the cutter without belt slip. Accordingly, a reduction gear of $2\frac{1}{2}$: 1 was fitted. The gears are in steel, 20 d.p., $\frac{1}{4}$ in. face, and were both cut on the machine itself. The driving pulley is interchangeable with the larger gear, so that it can be restored to direct drive in a matter of seconds, the higher speed being an advantage when working with single-tooth fly-cutters. Several methods of power transmission were tried, but the simplest and most satisfactory was a straight drive as shown in the photographs. The power unit, by the way, is one used for driving a small high-speed lathe. In use, the two units are screwed down to a flat bench top at an angle to one another dictated by the position of the swinging arm.

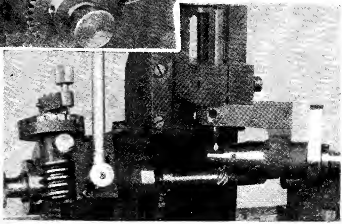


Showing cam and roller for small spiral gear

Operation

The cutting of spur gears is quite straightforward. The dividing head is clamped to prevent it rotating, and the swinging arm is also clamped in its 90 deg. position. The gears are then cut according to ordinary milling machine practice. Incidentally, I have only one carrier. All mandrels are shouldered down to $\frac{1}{2}$ in. at one end, and made a good fit in the bore of this carrier; also, they are all of the parallel screwed type with the shoulder in the same place. Thus the risk of carrier slip is reduced to a minimum, and the blank positively located.

The production of spiral gears is, however, the main function of the machine. The gear blank is mounted between centres in the normal way. The dividing-head clamping screw is removed, and the sheet-metal cam is attached to the drum by its three screws. The cam is made right- or left-handed according to the hand of the gear being cut. My

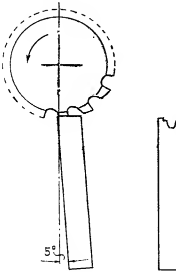


Showing method of setting fly cutter to centre-line of machine

*Continued from page 214, "M.E." February 6, 1947.

cams are made of 16-gauge sheet brass, which is first cut into rectangular pieces. The cam angle is then marked off with a protractor and cut to shape. This gives a right-angled triangle with the hypotenuse forming the working edge of the cam. It can now be bent quite easily round the dividing-head drum with the fingers alone, and secured in place. Small washers are used to raise the cam $\frac{1}{16}$ in. from the surface of the drum to enable the roller that bears against the not affect the spiral angle of the gear. It is to give side clearance only—the cam itself controls the spiral angle. If the blank is now fed into the cutter by means of the rack and pinion, the roller bearing against the cam will cause the dividing-head and blank to rotate, thus producing a spiral. After a cut has been made, the motor is stopped and the path retraced with the cutter stationary Dividing is carried out in the normal way, and the next tooth proceeded with. Each of the teeth in the bronze spiral gear (20 d.p.) shown in the photograph, was cut with one pass of the cutter. It has been found more satisfactory in practice to keep the cam in contact with the roller by hand, as a more sensitive feel of the cutting operation can be obtained in this way.

So far, the description has applied to the cutting of gears with a shallow spiral angle (up to 45 deg.). For gears with a steep spiral angle, however, a slightly different method is used. It was found that in this case, applying the feed to the table was not satisfactory, as owing to the acute angle of the cam, there was a big mechanical



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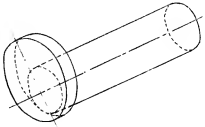

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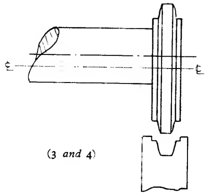
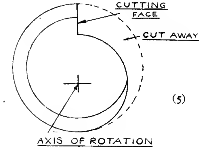


(3 *and* 4)



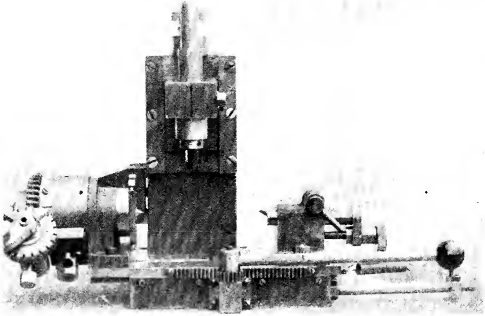
(5)

Steps in production of single-tooth gear cutters

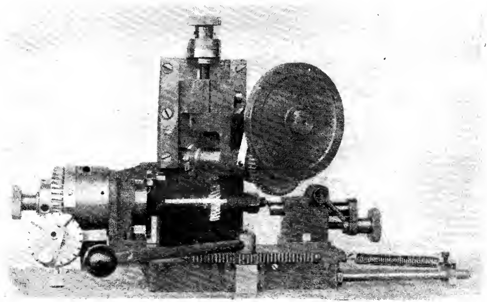
cam to make good contact. Two positions of the roller bracket are provided, according to whether a right- or left-handed cam is used, in order to keep the point of contact at centre height. The swinging arm is now set over to correspond with the spiral angle of the gear, again left- or right-handed. In my case, I have engraved the top of the swinging-arm bracket in degrees to assist in this adjustment. It must be noted that the angle at which the cutter is presented to the blank does

disadvantage. Accordingly, the feed lever was transferred from the table to the dividing-head, as can be seen from the photographs. Thus the table movement is controlled by the dividing-head *via* cam and roller.

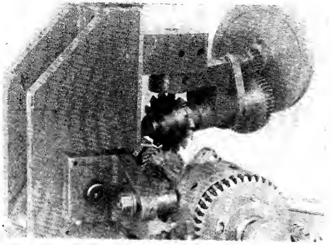
Double helical gears can be made by cutting the two hands separately, and pinning or otherwise securing them together. Alternatively, they can be cut solid if the centre portion is recessed to allow for cutter clearance.



End-milling spindle (unfinished) in place for cutting keyways, spines, etc.



Set-up for cutting large spiral gear (" 1831 "). Note feed is applied to table.



Showing cam and roller for large spiral gear

The first experimental spiral gear to be cut on the machine showed up a point which had not been foreseen. It is that the angle of the cam is not necessarily that of the spiral angle of the gear; in fact, it is only so when the diameter of the gear is the same as that of the drum round which the cam is wrapped. Accordingly, some modification has to be made to the cam angle, and is arrived at as follows :—

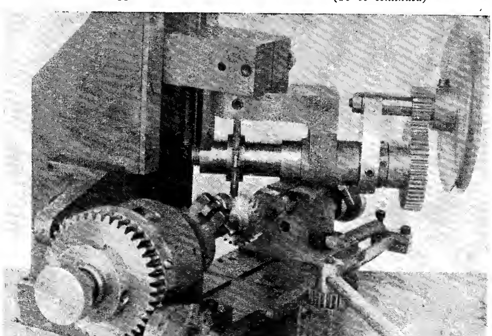
Since the spiral pitch of the gear is identical with that of the cam, the tangents of their spiral angles are in direct ratio to their diameters and the following formula applies :—

$$\text{Tan}\ \theta = \frac{M \tan \alpha}{D}$$

Where θ = Cam angle;
M = Diameter of cam drum
α = Spiral angle of gear
D = Pitch diameter of gear.

The bevel gear attachment consists simply of an angle-plate on which a simple form of dividing-head, with direct indexing, can rotate in a vertical plane to suit the angle of the bevel. This arrangement does not give a true bevel tooth, but if the face is kept narrow, they work satisfactorily.

(*To be continued*)



Cutting large spiral gear

The "Scope" Lathe

An original and highly versatile machine, introducing many novel features of design

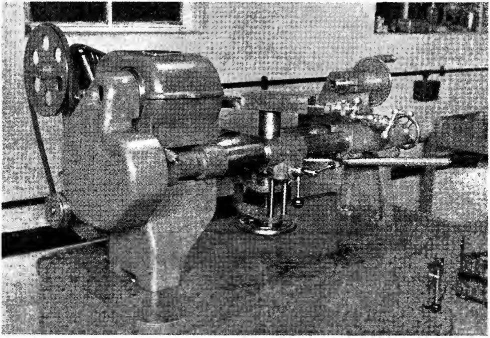
THE quest for the "ideal" lathe has been going on for many years now, but the zeal of its pursuers shows little sign of flagging. As pointed out so often in these pages, however, hardly any two persons agree as to the interpretation of the term "ideal." In some cases it is taken to mean a severely simple machine tool, but as near perfection as possible in its ability to produce accurate work, within the sphere of orthodox turning. More often, an attempt is made to increase the already wide range of uses to which the lathe can be adapted, and to develop it into a "universal" machine tool, capable of dealing with practically any machining operation required in the small workshop. Some very ingenious types of lathes have been designed with this end in view, but some of them have defeated their own object, by their failure to perform efficiently in their basic function, or undue complication in respect of attachments or convertible parts.

One of the most ingenious efforts to increase the versatility of the small lathe has recently been brought to our notice, in the machine illustrated here. It consists of a 4-in. screw-cutting lathe, having a maximum distance of 14½ in. between centres, and embodying all the standard features of a soundly-designed machine tool, while being capable of adaptation to many unusual purposes.

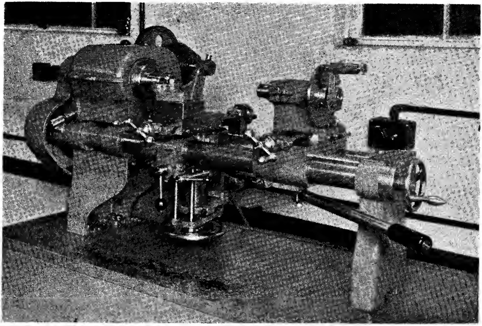
The bed of this machine is of twin tubular construction, the material used being nickel chrome cast iron of high surface hardness, ground to close limits of diameter and parallelism. Enclosed in the front tube is the lead screw, a slot being cut in the underside of the tube to allow of the engagement of the feed nut attached to the saddle.

The headstock is generally of orthodox design, the mandrel being fitted in precision taper bearings, back geared, and equipped with tumbler reverse gear to the screwcutting mechanism. A motor countershaft is fitted at the rear, and all gearing and belts are enclosed, the main headstock cover acting automatically as a belt tensioning device, so that lifting the cover slackens the belt to allow of speeds to be changed, and re-closing it tightens the belt to working tension.

Ten spindle speeds, from 38 to 1,500 r.p.m., are provided by the standard driving equipment. The lead screw is ⅝ in. diameter by 8 t.p.i., and a full range of threads from 4 to 64 t.p.i. can be



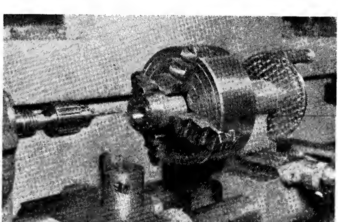
The "Scope" 4-in. lathe from headstock end



View of lathe showing saddle and tailstock fittings, also lever feed device

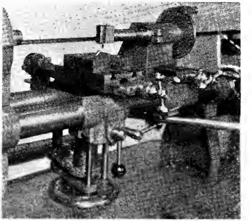
cut with the change-wheels provided, the addition of a 63-toothed wheel providing for metric threads.

The saddle consists of a casting bored horizontally with two parallel holes to fit the tubes of the bed, and having a vertical hole centrally between them to accommodate a sliding column, equipped with screw elevating gear, and also means of axial rotation. Two interchangeable columns are provided, one being of plain cylindrical form, slotted at the upper end and provided with a clamp to hold a cutting tool. In this way, the tool is applied vertically to the underside of the work, instead of on the horizontal centre line as usual in lathe practice. This arrangement is distinctly unorthodox, but several advantages are claimed for it in practice: (*a*) The diameter of workpiece which can be operated on is equal to the maximum swing over the saddle, the room which would normally be occupied by the cross-slide being available for increased swing. (*b*) It provides an extremely simple but highly rigid tool support, the overhang of which decreases with increasing work diameter. (*c*) The operator, when seated in front of the lathe, can view the performance of the cutting tool quite comfortably. (*d*) When boring, with a tool clamped horizontally across the top of the column, the tool cuts along the bottom of the bore diameter, giving improved visibility. (*e*) Increased accessibility is provided with this arrangement, as compared to that afforded when using a tool in the normal position.



Tailstock with chuck and index plate fitted for drilling a circle of equally spaced holes. (Vertical turning tool in saddle slide also shown)

The alternative column is equipped with an integral horizontal slideway, forming an orthodox cross slide, and capable of being fitted with a compound slide-rest, or other tool clamping device or rest. Thus the assembly can be utilised to carry out turning in the normal way, but with the added advantage of positive height adjustment to the tool. Swivelling on the centre column, the slide assembly can be set at any angle, or traversed round for spherical turning.



Using the tailstock barrel to carry a tool for shaping work held on cross slide

The base of the tailstock is a casting somewhat similar to that of the saddle, but without the vertical bore, and a cross-slide is provided, which gives a much greater range of motion than the usual set-over tailstock. It has a large diameter barrel, the nose of which is equipped with a thread identical to that of the mandrel nose, the bore and tapered socket being also the same size. In this way, chucks or faceplates, with work in position if desired, can be transferred from the live headstock to the tailstock. The rear end of the barrel is fitted with indexing gear, the combination of these features enabling equally spaced holes on a given pitch circle to be drilled, and many similar milling and drilling operations, which would normally call for the use of special attachments, to be carried out. In an alternative arrangement, the tailstock equipment is further improved by the addition of worm indexing gear.

Reciprocating movement can be applied to either the tailstock or saddle, by means of a simple lever mechanism, which can be attached to their undersides. If one of the slides is clamped and the other left free, the latter is moved by the action of the lever, and this motion can be utilised to perform shaping and slotting operations, also to provide a sensitive lever feed to the tailstock for fine drilling. The stroke and leverage of the feed can be adjusted, and it can also be made to operate an automatic feed on the tail-stock cross-slide, in either direction, operating through a ratchet on the feed screw, which can be adjusted to produce a slide movement of 0.002 in. to 0.006 in. per stroke.

A machine of this type can only be successful in practice if very soundly and accurately built, and we are assured that all components are made to very close limits of precision, and from high-grade materials. Particular care has been taken to ensure that rigidity under cutting stresses is not sacrificed for the sake of mere talking points, or spectacular features of design. In addition to functional design, considerable attention has been paid to the aesthetic aspect of design, in the endeavour to produce a machine, not only of utility, but also of pleasing appearance.

The standard equipment of the lathe includes the two saddle vertical slide columns, set-over tailstock, and lever feed gear. Special equipment includes a compound slide-rest with tool post, machine vice to fit cross slide, longitudinal saddle stops, fixed steady, chuck backplates, and 5 in. self-centring and four-jaw chucks.

This lathe is manufactured by the Scope Engineering Co. Ltd., Caldecott Street, Rugby, to whom all enquiries concerning it should be addressed.

Letters

Obsolescent Steam Engines

DEAR SIR,—Several letters have been published in THE MODEL ENGINEER from correspondents, regretting the passing of steam road locomotives, ploughing engines, etc. Another type of steam plant which has almost if not quite, disappeared, is the Naval pinnace or vedette boat, which has been superseded by internal-combustion plant.

The firm of marine engineers where the writer served his pupilage specialised in machinery and boilers for this type of boat and fine little plants they were.

The 23-ft. pinnaces (open boats), had vertical compound condensing engines with cylinders 3 in. and 6 in. × 4½ in. stroke and ran at 500/600 r.p.m. The boilers were miniature marine-type with extended smokebox; forced draught was obtained from a fan bolted to the front of the boiler and driven off the forward end of the engine, through the medium of a pulley and steel spring belt. Air was delivered to a closed ashpan, a throttle being arranged so that the fire door could not be opened unless the air supply was cut off, otherwise the fire was blown out in the stoker's face.

The 40-ft. vedette boats, or admiral's barges, had a similar type of engine with cylinders 5¾ in. and 11½ in. × 9 in. stroke and also ran at about 500 r.p.m.

The boilers for these boats were usually of the "Mumford" water-tube type, consisting of a steam drum 15 in. to 18 in. diameter and two water drums about 12 in. × 4 in., connected by banks of solid-drawn steel tubes about 1 in. diameter.

These boilers worked in a closed stokehold,

separated by a bulkhead from the engine-room, and the forced draught was provided by a fan driven by a single-cylinder steam engine.

These boats, like the 23-ft. and 32-ft. ones, were fitted with outboard condensers consisting of two copper tubes running alongside each side of the keel, the steam being admitted at one end and the air pump (which by the way was driven direct off the the crosshead of the low-pressure cylinder) being connected to the other end; a good vacuum was obtained without any circulating pumps being required or any chance of leaky condenser tubes.

These engines were usually obtained in batches of ten or twenty, and all spare gear, such as link-motion, eccentric-rods, brasses, etc., had to be interchangeable. When it is realised that, at this time, the works had only one milling machine, a vertical one used for rough milling the eyes of connecting-rods, drag-links, etc., and, of course, no grinding machines, other than the usual emery-wheels for sharpening tools, it will be seen that the class of work turned out by the fitters must have been really first-class, especially as it was very rarely any parts were rejected by the Admiralty Inspectors.

The writer considers that Naval pinnaces, especially the 40-ft. and 56-ft. types, make excellent working models, as they can be made to a reasonable scale, and have very few deck fittings to get damaged whilst being run.

Yours faithfully,

Exmouth. A. D. S.

Model Traction Engines

DEAR SIR,—I read with great interest Mr. G. R. Cross's description of his fine little agricultural single-cylinder Burrell traction engine in the January 9th issue. He says one should follow a good standard class of known types. This he has followed very nicely, but as one fairly conversant with these engines (mostly of the compound Showman's-type), I would notice any variation from standard fittings. He has not put in the compensation pin oval piece round hub of back road wheel. Also, the regulator lever was *not* an upright one, but one which lay in a *horizontal* position.

Now, the Burrell tractor *did* have an upright regulator lever. Only little things, but one must keep "in line" when following the prototype. Some features cannot, of course, be followed in a small job, but the etceteras I speak of can be arranged, though the horizontal lever may be awkward to operate on a small engine like this; so perhaps that is *why* the upright one was adopted, though not stated by Mr. Cross, as a workable alternative.

Yours faithfully,

Erith. ALAN BLOUNT.

Shaded Drawings

DEAR SIR,—Your review of the new quarterly, *Railway Pictorial*, is of considerable interest and I think your comments on the question of "cut-out" blocks will find general agreement; this sort of thing to be done effectively requires a real specialist and one who combines a comprehensive knowledge of locomotives with his artistic and manual skill.

I find myself in disagreement, however, on the question of line drawings being best left as plain mechanical drawings, particularly in a paper of the nature of the one under review. Provided it is properly and skilfully carried out, shading can add immensely to the "readability" (to coin a rather revolting word) of a drawing without in the very least detracting from its value as an accurate record of the article depicted. If anybody doubts that, I would refer them to such works as Clarke's *Railway Machinery*, or Tredgold on *The Steam Engine*, where large use is made of shading, etc., most beautifully carried out, which, whilst enhancing the clearness of the drawings as pictures, in no way interferes with their value as working drawings. Bearing in mind that the main purpose of *Railway Pictorial* is inherent in its title, I should say that the method used in the illustrations referred to is fully justified; this method gives many of the advantages of perspective without any of its disadvantages.

Yours faithfully,

Harrow. K. N. HARRIS.

[We quite agree with our correspondent's opinions, but we venture to suggest that there can be no comparison between the attempts at "pictorialising" the drawings we referred to and the superb examples of shading found on some of the old drawings like those in "Tredgold." We have no objection to *accurately*-shaded drawings; but such crude and inaccurate practices as the complete blacking-in of wheel tyres, "ornamental" black borders to tank sides, cab-sides and tender-bodies, are just "not done" on mechanical drawings.—ED., "M.E."]

Reviving the Past

DEAR SIR,—I greatly appreciate the letter from Mr. K. N. Harris in the January 16th issue, and would like to add my plea for the republication of some of the earlier designs which have appeared in THE MODEL ENGINEER.

In my somewhat extensive acquaintance with clubs I have been considerably impressed with the fact that the younger members have no knowledge of the many masterpieces which have been described in earlier years; but it has been clear that when reference to such classics has been made, they are eager for information.

I am sure that the republication of these old-timers would be greatly appreciated by young and old alike, by the young because new avenues of interest would be opened to them, and by the old for nostalgic reasons.

Lacking the wide knowledge of Mr. K. N. Harris, I cannot mention these classics by the names of their designers or builders, but I can certainly recollect the intense pleasure I derived from perusing occasional issues of THE MODEL ENGINEER some forty years ago. In writing thus, I do not wish to join those who allege that THE MODEL ENGINEER is not as good as it formerly was, since *autres temps, autres moeurs*.

Yours faithfully

West Wickham. A. B. STORRAR